(12)

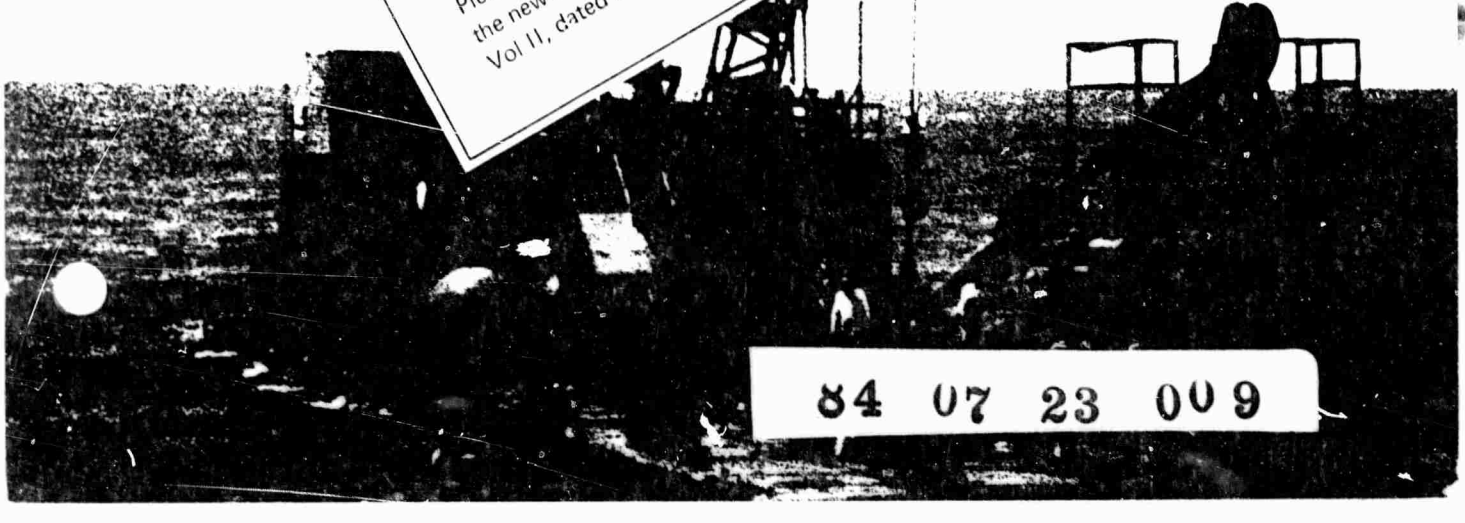
guide to technical documents

volume II

january 1983 through december 1983

naval civil engineering laboratory
port hueneme, california

Please disassemble this document and remove old pages and insert the new material supplied in NCEL's Guide to Technical Documents, Vol II, dated Jan 1973 through Dec 1981.

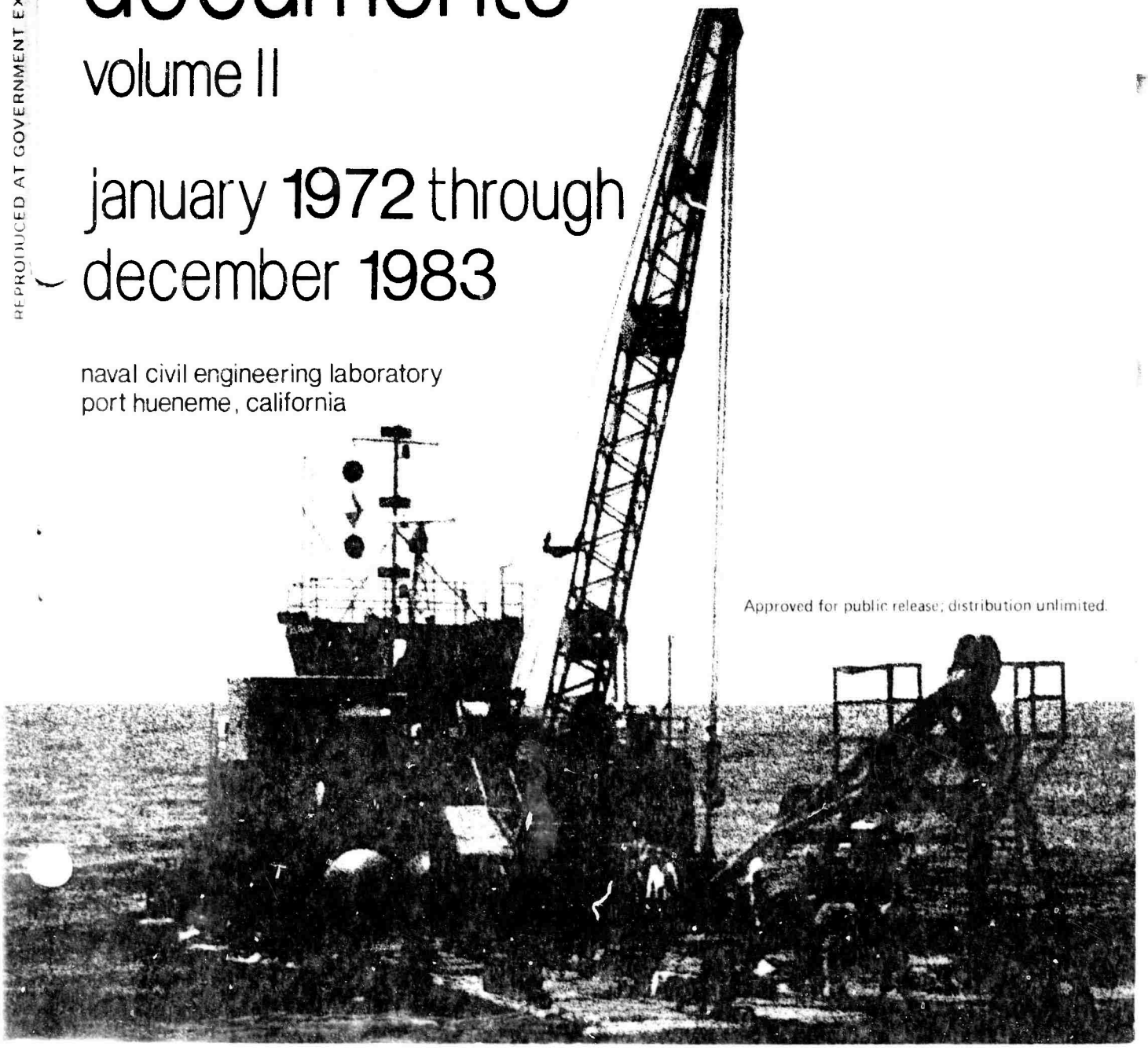


guide to technical documents

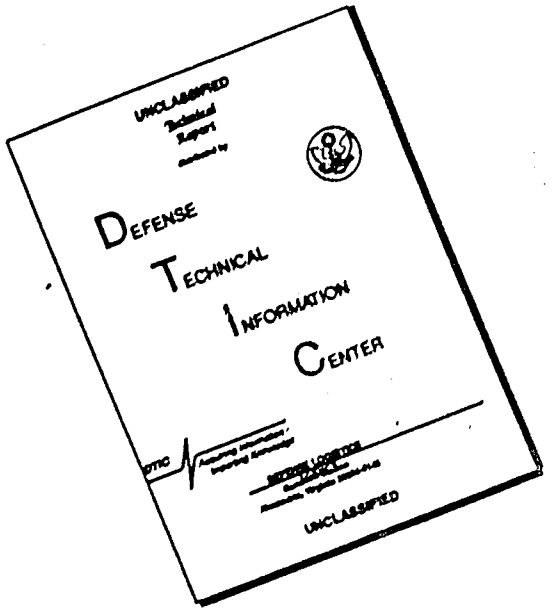
volume II

january 1972 through december 1983

naval civil engineering laboratory
port hueneme, california



DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

This "Guide to Technical Documents" lists all the formal reports that have been published by NCEL on research, test, and evaluation. These reports are available to addressees from the following sources:

Unclassified, unlimited documents – available to general public

National Technical Information Service (NTIS)
Operations Division
5285 Port Royal Road
Springfield, VA 22161 (703) 557-4650

Classified and limited distribution documents – available to Department of Defense agencies and their contractors only

Defense Technical Information Center (DTIC)
Cameron Station
Alexandria, VA 22314

When ordering documents from either NTIS or DTIC, order by AD, ATI, or PB number, if known. Otherwise, order by NCEL document number, title, author, and date. In order to obtain NCEL documents quickly, it is recommended that each Engineering Field Division and Public Works Office register with DTIC in advance. Request a DTIC Form 1540, Registration for Scientific and Technical Information Services, from DTIC, Attn: DTIC-TSR-1. Be very careful in circling the fields of interest identified on the back of the form because you can order later only those fields of interest that you have had certified and registered now. The form will be returned to you with a user code assigned.

It is also recommended that you set up an account with NTIS for billing purposes by forwarding a deposit of about $50.00, the amount depending upon anticipated use of the service.

If documents are needed urgently, DTIC maintains a 24-hour answering service for your convenience. Call –

(202) 274-6811 or autovon 284-6811

and follow the instructions of the recorded voice. You should be aware that an 8-second pause in your conversation will automatically disconnect you.

If you have queries concerning NCEL documents, please contact NCEL:

Mr. Ivan Wanless
Presentations and Graphics Center, Code L07
Naval Civil Engineering Laboratory
Port Hueneme, California 93043

R-886
Cable Burial in the Deep Ocean Floor, Apr 1981, P. K. Rockwell, J. H. Engel, W. B. Piercy, ADB058924L

Bottom-fishing equipment frequently damages or breaks Navy bottom-laid telecommunication cables, causing substantial repair costs and interruption of critical communication systems. The Naval Civil Engineering Laboratory (NCEL) has developed and validated an engineering concept for a Deep Ocean Cable Burial (DOCB) system to provide the Navy with a means of burying cables 3 feet deep in ocean sediments, at speeds not less than 1 knot in water depths to 6,000 feet. The DOCB system concept includes a remotely controlled machine which buries previously laid cables; it is powered and controlled from a surface ship via an electromechanical umbilical cable. The machine is self-propelled by ducted thrusters and supported on water-lubricated skids. The excavation system comprises an orbital vibrating plowshare and a vertical water jet. Full-scale field testing at NCEL focused on: (a) quantifying orbital vibratory plow drawbar forces; (b) evaluating a vertically impinging water jet trenching subsystem; and (c) demonstrating the effect of water lubrication on the soil drag of a flat-bottomed skid. Field tests showed that drawbar force was reduced 70% by applying elliptical orbital vibration to a plow. The water jet tests demonstrated that a 2-1/2-inch nozzle can cut 36 inches deep in 1- to 2-psi clay at a nozzle pressure of 75 psi and flow rate of 1,200 gpm. The water-lubricated skid tests showed that forcing a layer of water between the skid and soil reduced the skid/soil drag by 50%. Finally, a full-scale experimental cable burial vehicle was tested in shallow water. This 360-hp vehicle buried cables in excess of 42 inches deep at 1.2 knots.

R-887
Laser-Based Noncontacting Displacement Measurement, May 1981, G. Warren, ADB058925L

A laser-based noncontact method of directly measuring time-displacement has been developed as an alternative to electrical transducers and hard-wire cables. A biaxial device employing a He-Ne laser and position sensor has been built to monitor structural motion at distances up to 350 meters with displacement accuracies better than 2 mm. The method proved valuable in measuring dynamic displacement of large structures where accessibility was limited or where fixed points of reference were nonexistent. Also, a means of measuring triaxial displacement has been outlined.

R-888
Design Procedures for Embedment Anchors Subjected to Dynamic Loading Conditions, Nov 1981, H. G. Herrmann, ADA110325

This report provides procedures for determining allowable design loads for embedment anchors under all types of dynamic loads, including impact (as from a ship driving into a mooring), cyclic (as from a buoy or ship riding in a mooring system during a storm), and earthquake loading. The design procedures are simplified in the form of guidelines applicable to most site conditions and are complete to the point of including the following: (1) site survey requirements; (2) detailed static design procedures; (3) description and definition of dynamic loads; (4) design procedures for impact, cyclic, and earthquake loading; (5) selection and use of appropriate factors of safety; and (6) description of available existing NCEL embedment anchor hardware. While the procedures are designed specifically for the NCEL-developed family of propellant (often termed explosive) embedded anchors, they are applicable to other types of embedment anchors and screw anchors. For hardware configurations or site conditions beyond the range of the guidelines presented here, references to appropriate other documents are provided.

R-889
ESKIMO V1 Results, Nov 1981, P. E. Tafoya, ADB064461L

ESKIMO V1, sixth in the series of Explosive Safety Knowledge IMprovement Operation Tests, was conducted to test and evaluate the safety and performance under blast loading of flat-roofed, earth-covered, box-shapes, reinforced concrete (smokeless powder and projectile) storage magazines. The test magazines were located at the minimum intermagazine distances allowed for magazines of the box type. The two magazines tested, the Type IIB (old design) and Type A (new design), were halfscale models characterized by the box shape, similar geometric dimensions, interior three-bay design, and two entrance doors located in the headwall. The donor structure was a mock-up of a Type IIB magazine and simulated the geometry and mass of the roof, earth-cover, and headwall of the prototype. The donor charge consisted of 60 Mark 16 torpedo warheads containing the equivalent to 44,000 pounds of TNT, corresponding to 350,000 pounds of TNT at full scale.

Both structures survived the test with limited damage. The Type IIB doors failed during the bast and were blown into the structure; permanent roof deflections were limited (less than 1 inch); and minor cracking of the concrete roof and headwall was evident. The Type A magazine sustained priarily architectural damage to the roof parapet; roof deflections (less than 0.5 inch) were noted, with minor cracking of the concrete roof. Both magazines, if in the field, could be reusable after minor reworking.

R-890
Design Guidelines for the Development of a Trencher for Cutting Rock, Coral, and Frozen Sand in the Nearshore Environment, Dec 1981, W. R. Tausig, ADB063763L

Cables and pipelines that traverse the nearshore region often fail due to damage from hydronamic forces and dragging anchors unless they are protected. Trenching and burying cables below the seafloor has been shown to be a viable method for protecting cables and pipelines in nearshore and coral areas. This report summarizes nearshore trencher studies at the Naval Civil Engineering Laboratory, and surveys recent advances made in nearshore trenching technology. As a result of these studies, NCEL conducted a development program to demonstrate the feasibility of using cavitating waterjets for trenching in rock and coral. The results of this development program, along with a state-of-the-art review of mechanical trenchers combined with the data resulting from the cavitation waterjet development program, are presented at the conclusion of this report as guidelines for nearshore trencher design.

R-891
Underwater Splicing of Submarine Coaxial Cable, Feb 1982, A. T. Inouye, W. R. Tausig, ADB064462L

The Naval Civil Engineering Laboratory has developed a self-contained unit that can splice submarine coaxial cables in place in the seafloor. The unit restores electrical and mechanical characteristics of the cable by preparing the cable's end and inserting it into the splice. Experimental splice models were attached to cables in seawater at pressures up to 5,000 psig and were subjected to 6,000 VDC. Leakage currents were less than 1 μA. The splice was also subjected to steady state DC voltages to 35,000 volts and 10-nsec transient at voltages to 70,000 volts peak with no electrical degradation. Attenuation of the splice was measured at 0.01 db/m at 13 MHz. Strength restoration consists of a modified commercial sliding cone device with a holding capacity of about 4,600 pounds on a copper-cladded steel cable. The splice is filled with castor oil for pressure compensation and prevention of high-voltage breakdown or corona noise. The development of the splice shows that an underwater splicing technique on the seafloor is feasible.

R-892
Geotechnical Diver Tool Development, May 1982, J. A. Bailard, ADB065655L

Seven geotechnical site survey tools were developed for diver use; these include: an impact sediment corer, a vacuum-assisted sediment corer, a rock corer, a vane shear device, a miniature standard penetration test device, a water-jet probe, and a rock strength device. Laboratory tests and field tests and evaluation of the tools provided adequate geotechnical information to support the design of most nearshore Navy installations.

R-893
Design and Performance of Thermal Sensors for Measuring Ocean Currents, May 1982, A. P. Smith, T. R. Kretschmer, B. C. Streets, ADB065661L

The development of an ocean current sensor based on thermal anemometry principles is described. The sensor accurately measures current speed to ±5% of reading and current direction to ±8 degrees. Significant problems associated with the use of thermal sensors in water have been solved. For example, a unique antifouling technique, based on electrolytic hypochlorination, was developed that controls biofouling indefinitely on the sensor surface; the overall strength of the sensor was greatly increased by substituting ceramic substrates for quartz substrates; and a waterproof coating, based on Parylene D, increased sensor life expectancy from several days to several weeks. This report describes the design and manufacture of the sensor. An evaluation of the results obtained from laboratory and ocean testing of the sensor is presented along with a description of the antifouling technique. The theoretical background associated with sensor operation is covered briefly.

R-894
Air Infiltration and Stratification Investigation of Air Force and Navy Aircraft Hangars, Jun 1982, J. L. Ashley, ADB066649L

An investigation was conducted to measure the air infiltration and stratification characteristics associated with Air Force and Navy aircraft hangars. Four hangars were evaluated at different locations throughout the United States during the 1980-1981 winter. Air infiltration measurements were accomplished by measuring the decay rates of a tracer gas (sulfur hexafluoride) with hangar doors opened and closed. Floor-to-ceiling temperature gradients were measured and correlated to outside air temperature. Concepts to reduce stratification and air infiltration were evaluated and recommendations made. Lower limits for air infiltration were established, and a method to predict the severity of stratification was developed. (Also published as AFESC/RDVA ESL-TR-81-40)

R-895
Seawater Hydraulics: Development of an Experimental Vane Motor for Powering Diver-Held Tools, Jul 1982, S. A. Black, ADB068205L

The Naval Civil Engineering Laboratory is developing a diver-operated hydraulic tool system that uses seawater as the working fluid. In the fall of 1978, work began on the development of an experimental vane motor capable of powering diver-held tools. Material requirements for the vane motor components were investigated in detail, and an engineering model of the motor was designed and fabricated using the most promising materials. The best results were obtained by using Torlon 4275, a high-strength thermoplastic, for the vanes, side plates, and bearings, and Inconel 625, a high-nickel-based alloy, for the housing and rotor. Based on the results of engineering development, an experimental vane motor was fabricated and tested in the laboratory. The motor, with a volume of about 25 $in.^3$, weighs only 5 pounds, and produces 3.3 hp at 1,600 rpm with 80% overall efficiency when supplied with 7 gpm of seawater at 1,000 psi. More than 60 hours of full-power operation have been achieved. The results to date of the development and testing are presented in this report.

R-896
Safe Underwater Electrical Power Transmission, Aug 1982, L. W. Tucker, ADB067752L

To enable divers to safely use electrical equipment underwater, the power transmission system design must include techniques for protecting the diver from electrical shock hazards. The Naval Civil Engineering Laboratory (NCEL) has developed an improved ground fault protecting system that can protect the diver when used in conjunction with other methods of protection. The NCEL ground fault system will shut down power to the underwater equipment in less than 10 msec if a breakdown in the insulation resistance of the transmission lines allows more than 2.5 mA to flow to ground. This report reviews the methods that can reduce the possibility of electric shock to the diver. The development of the NCEL ground fault detection is also presented along with the results from ocean tests of an electric-powered vehicle equipped with the protection system.

R-897
Improved Split-Pipe Cable Protection Techniques, Dec 1982, R. L. Brackett, W. R. Tausig, ADB073775L

The U.S. Navy currently maintains and operates numerous underwater power and signal cables. Most of these cables utilize split pipe systems to protect the cable from damage in the surfzone and when crossing exposed rocky seafloors. Past experience has shown that the hardware used to install the split pipe system lacks the reliability and maintenance-free operation required for the life of the cables. Based on previous experience with cable failures, the areas determined to be in greatest need of investigation are fasteners for holding the split pipe halves together, immobilization of the pipe, and cathodic protection for the entire system. As a result, NCEL tested prototype and commercially available hardware components which appeared to be suitable replacements for the existing split pipe hardware. The candidate hardware was then used in a 300-foot-long test section of split pipe installed March 1976 at Anacapa Island, to be inspected during a five-year period.

This report summarizes the candidate hardware investigation, the installation and periodic inspections of the Anacapa Island test installation, and finally the removal and analysis of that test installation.

R-898
Potable Water Treatment for Diego Garcia, Jan 1983, D. B. Chan, J. S. Williams, ADA128756

This report documents an engineering investigation for the development of a cost-effective water treatment system to be used at Diego Garcia. The system must effectively remove or reduce TDS, color, taste and odor, turbidity, and the excessive amounts of organics and microorganisms so that all EPS's drinking water standards can be met. A three-stage water treatment system consisting of a multimedia filter, a carbon filter, and a RO system was tested at Diego Garcia and proved to be the most cost-effective treatment process.

R-899
A Design for a Test Bed Scour Jet Array for Mare Island Naval Shipyard, May 1983, J. A. Bailard, J. M. Camperman, ADA133240

In response to rising dredging costs, the Navy has developed a number of concepts for sedimentation control systems, which serve as alternatives to conventional dredging. One concept, the scour jet array, prevents sedimentation through the scouring action of submerged near-bottom water jets. This report presents the design of a scour jet array test bed which will be used to verify proposed scour equations and to evaluate new design technology. The 68-jet array covers a total of 366 m (1,200 ft) of quaywall and is capable of scouring to distances of 30 m

(98 ft) from the wall. The jet array is powered by a 0.379 m^3/sec (6,000 gpm), 336 kW (450 hp) vertical turbine pump. An automatic control system is included that utilizes pneumatically actuated valves and a microprocessor controller. The microprocessor also serves as an instrumentation data logger, facilitating testing as well as routine operational checking.

R-900
Encapsulation of Friable Insulation Materials Containing Asbestos, May 1983, E. E. Lory, M. J. Hienzsch, ADA129872

This document presents information on the encapsulation of asbestos-containing friable insulation materials (FIM). Encapsulation, which is a procedure to seal in asbestos fibers that may be subject to ready release on minimal disturbance, is a new alternative approach to the abatement of hazards from asbestos insulating materials. Encapsulation may be used in specific sites and cases instead of removal of asbestos-containing FIM. This document introduces the facilities architect or engineer to encapsulant materials, established and planned testing criteria, application techniques, the advantages and drawbacks to using encapsulants, and a guide specification for encapsulation of asbestos-containing FIM.

R-901
Concepts for Secure Magazine Doors, May 1983, T. L. Pickett, ADB076816L

The U.S. military has vast stockpiles of weapons and explosives referred to in general as Arms, Ammunition, and Explosives (AA&E). Because AA&E have considerable value to criminals and terrorist groups, they have been classified, by order of sensitivity, into risk categories I through IV. All risk category I and bulk quantities of risk category II AA&E are stored in "standard" magazines (more than 80% are earth-covered). The earth-covered portion of the structure and the headwall have been tested and are considered the most secure components, leaving the door system as the most pressing magazine security problem. The need to solve this security problem has led to the current research and development on magazine door systems. This report discusses existing magazine door security, establishes rational security requirements, and explores the feasibility of achieving these requirements. Several concepts are presented that show promise for greatly improving magazine security at reasonable cost. The concept of laminar construction (layering the proper materials in the correct thickness and sequence) and the concept of using stand-off structures for less secure magazine doors are recommended for advanced development.

R-902
Crows Landing Bomb Damage Repair Test - FRP Membrane Repair Methods, May 1983, P. Springston, ADB077212L

This report documents results of F-4E aircraft test operations on two simulated bomb craters repaired with crushed stone and fiberglass-reinforced polyester (FRP) membranes. Craters of 20 and 40 feet in diameter were excavated in runway 12-30 of the Naval Auxiliary Landing Field, Crows Landing, Calif. Excavation closely approximated actual bomb craters. The smaller crater was repaired with 24 inches of crushed stone and a surface-mounted 3/8-inch FRP membrane. The larger crater was repaired with a section consisting of a 1/8-inch FRP membrane fabricated in place on the surface of backfilled debris, 12 inches of compacted crushed stone, and a surface-mounted 3/8-inch FRP membrane. Both craters were subjected to 49 F-4E operations including constant speed taxis (with and without braking), touch and go landings, and takeoffs. Aircraft operations were conducted in both a heavy (takeoff) and lightweight (landing) configuration. Both wet and dry runway conditions were included. Crater repairs were further tested by trafficking with 1,440 passes (150 coverages) of a load cart simulating a heavyweight F-4E. Both repair methods were found to be structurally sound. The FRP covers were undamaged by all tests (including braking and wheel spin-up) and provided excellent protection from foreign object damage (FOD). Adequate skid resistance was provided by the dry FRP covers. The wet FRP provided poor skid resistance and recommendations are made for anti-skid coatings. The anchor system was found to be susceptible to damage from slide-in impact of the F-4E tailhook at velocities equal to or greater than 40 knots. (Also published as AFESC ESL-TR-82-36.)

R-903
Pulse Echo Ultrasonic Techniques for Underwater Inspection of Steel Waterfront Structures, Jun 1983, R. L. Brackett, L. W. Tucker, R. Erich, ADA133701

This report presents the results of laboratory and field tests to evaluate the capability of commercially available ultrasonic inspection systems to accurately measure the thickness of submerged steel waterfront structures. The objectives of the laboratory tests were to: (1) determine the measurement accuracy using three different methods of acquiring and interpreting the ultrasonic data, (2) identify operator training requirements and optimum information feedback techniques for the diver, and (3) analyze the electrical power transmission characteristics of the ultrasonic system and identify any potential safety hazards to the diver. Due to the problems associated with multiple front surface echoes, digital ultrasonic thickness gages should not be used as the only means of inspecting steel structures in areas found to have irregular front surface conditions or where the thickness readings are found to fluctuate rapidly over a small area. Field tests of the ultrasonic scanner and surface milling adapter have confirmed that results comparable to those obtained during laboratory tests are attainable during in-situ inspection of steel pilings; since the ultrasonic scanner and milling adapter technique is not truly nondestructive in nature, however, it should be considered an interim inspection procedure. Investigation of alternative inspection techniques that do not require material removal should be continued. A power system test circuit should be incorporated into any 100-VAC circuit used to power underwater ultrasonic test equipment. As an additional safety precaution, inspection divers should be required to wear neoprene wetsuit gloves and should be instructed not to reach through the air/water interface while holding any grounded electronic equipment in their hands. A series resistor-inductor network connected in parallel with the ultrasonic transducer should be incorporated into all cables greater than 100 feet in length to minimize near-surface noise due to electrical impedance mismatching.

R-S04
System Definition for Containerizing the Assets of Naval Mobile Construction Battalions, Aug 1983, R. H. Seabold, AD

The objective of the Naval Mobile Construction Battalion (NMCB) Table of Allowance (TOA) container system is to containerize the assets of the NMCB as listed in the NMCB TOA to the maximum extent practical for International Organization for Standardization (ISO) intermodal handling and transportability in a manner compatible with the Department of Defense Container Oriented Distribution System. The NMCB TOA container system may include general purpose containers, special purpose containers, containerized tactical shelters, and self-contained equipment.

Expertise in a relatively specific technology, requiring a knowledge of newly developed products, was employed to define the problem and provide guidance for system acquisition, but nothing was invented and no hardware was developed. System requirements were determined and system criteria were quantified. Economic measures of effectiveness and figures of merit were determined to set economic goals, assess progress, compare alternatives, isolate the

cost of special military features, and also to monitor or prevent cost escalation. Policy is covered in terms of preferences, priorities, and broad procedures. Shortfalls were cited for planning research and development. Several components from the Marine Corps Field Logistics System, the Navy Quick Camp System, and the Department of Defense Tactical Shelter System are recommended.

R-906
Container Marshalling Within a Combat Service Support Area, Nov 1983, P. S. Springston, C. I. Skaalen, AD

The capability of the Navy and Marine Corps to cope with containerized materials in an amphibious environment is severely limited. Currently, there is no established doctrine concerning the marshalling of containers ashore in support of a Marine Amphibious Force (MAF) level amphibious operation in a hostile environment. The objective of this report was to aid in the establishment of such a doctrine and to provide information of use to Marine Corps planners regarding the selection and use of material handling equipment. Concepts for container marshalling were reviewed with the goal of maximizing material throughput within the constraints of earthwork and surfacing construction, support, vulnerability, and the current Table of Equipment. Two alternative concepts for container marshalling were developed - a densely configured, throughput-efficient, relatively vulnerable layout; and a dispersed, less efficient, though more survivable, layout. Both concepts were satisfactory for operation of either of two mixes of material handling equipment. From this study it was concluded that neither the Caterpillar 988B, the Drott 2500, nor a typical commercially available straddle lift is an optimum container handler for Marine Corps requirements. Instead, it was recommended that a marginal terrain capable straddle lift be selected as a container handler for use in a Combat Service Support Area (CSSA). Containers should be loaded with identical items to minimize container handling during unstuffing. An optimum method of container loading prior to mountout and inventory control within the CSSA requires development. Container marshalling areas established in a conventional, high-threat environment should provide for distributed storage of containers as in the Container Distribution Point/Ready Issue Point concept discussed in this report.

include: multi-materials, bottom interaction, nonlinear material properties, material damping, payout reel-in, strumming effects, spatially varying current fields, imposed motions, and random wave loading. Results can be saved and reused during the current execution or at a later date. A free-field input reader is used.

N-1631
Traffic Testing of a Fiberglass-Reinforced Polyester Surfaced and Reinforced Crushed Limestone Base Course for Rapid Runway Repair, May 1982, P. S. Springston, ADB065621L

This report documents traffic tests of a rapid runway repair (RRR) method utilizing dual membranes of fiberglass-reinforced polyester resin (FRP). The test was conducted at the Rapid Runway Repair Test Facility of the Air Force Engineering and Services Center at Tyndall Air Force Base, Fla., during September 1980. A lower membrane, which is field fabricated at the debris-base course interface, reinforces the base course and prevents aggregate from being worked into the crater debris during trafficking. An upper prefabricated membrane functions primarily as a trafficable crater cap, preventing foreign object damage (FOD) to aircraft. The upper membrane also reduces rutting from rolling aircraft wheels in a 12-in.-thick crushed limestone base course overlying backfilled debris. The repair method for medium to large craters consists of the removal of upheaved pavement, backfilling the crater with usable debris to within 12 in. of the runway surface, field fabrication of the lower membrane concurrently with placement of 12 in. of crushed limestone, compaction and grading of the limestone, and positioning and anchoring of the FRP cover. In the tests, applied traffic consisted of 150 and 70 coverages of load carts simulating fully loaded F-4 and C-141 aircraft main gears, respectively. The upper FOD cover anchoring system was successfully tested and found to be capable of withstanding repeated horizontal loadings of 54,000 lb. Recommendations are provided for further evaluation necessary for the certification of the concept for rapid runway repair.

N-1632
Evaluation of NDT Equipment for Specialized Inspection, Jun 1982, G. Warren, ADB068191L

Surveys and evaluations were made of commercially available portable systems for nondestructive test (NDT) applications to the specialized inspection areas of waterfront facilities, cables and wire rope, built-up roofs, and utility/POL distribution and storage facilities. Some success was achieved by adaptation of equipment and techniques used in other NDT applications (e.g., nuclear moisture meters for roofing inspection, ultrasonics for measuring metal thicknesses of underwater structures, and magnetic induction for wire rope and cable inspection). However, NDT equipment state-of-the-art is deficient for providing capability to assess condition of wooden underwater structures, trackage foundations, and POL/utility distribution and storage facilities.

N-1633
An Assessment of State-of-the-Art Methods for Calculating Current Loads on Moored Ships, Jun 1982, P. Palo, R. Owens, ADB068225L

This report presents an examination of techniques for computing current-induced forces and yaw moment on moored vessels based on experimental data or procedures from nine independent sources. No validated full-scale data were located, so only relative evaluations were possible. For the lateral and longitudinal current forces, the nine sources were applied directly (or scaled) to two representative hull types. This comparison shows extreme differences among the nine methods. It is concluded, based on these differences, that the present uncertainty in these state-of-the-art current force predictive methods is ±80% for head currents (longitudinal force) and ±50% for beam currents (lateral force). Comparisons are also presented for the current-induced yaw moment and water depth (blockage) correction factor. The differences among these latter two are even greater than those for the lateral and longitudinal forces. The Navy's DM-26 approach was found to be inconsistent and can be in error by a factor of 5; the latest draft (90%) of the ongoing revision of that manual (DM 26.6) was considered acceptable except for the longitudinal forces. Because of uncertainties in the scaling criteria, full-scale measurements are recommended to allow proper evaluation of these various methods.

N-1634
STATMOOR - A Single-Point Mooring Static Analysis Program, Jun 1982, J. V. Cox, ADA119979

STATMOOR is a static mooring analysis program written in BASIC language and is one program in a hierarchy of programs developed at the Naval Civil Engineering Laboratory for mooring analysis. STATMOOR analyzes the static response of a single-point moored vessel and hawser. The MENU arrangement of the program lends itself to a user-oriented conversational mode. The user has the option to enter, review, edit input, and obtain calculated results in printed tabular, video tabular, or video graphics form. Steady current, wind, and wave loads are considered. Wind load estimates are considered to be as accurate as the user's knowledge of the wind environment; current and wave loads are in a preliminary form and merit further refinement. STATMOOR was written to demonstrate the utility and ease of use of conversational mode programs and the potential for computer programs to replace bound design manuals. It is unique in that it incorporates recently developed wind load information, can confidently be used with little or no training, and is easily adaptable to most desk top computers.

N-1635
Drag Embedment Anchor Tests in Sand and Mud, Jun 1982, R. J. Taylor, ADB068224L

This report provides the results of conventional temporary and permanent mooring anchor tests in dense fine sand at Port Hueneme and normally consolidated silty clay at Indian Island, includes a preliminary analysis of the data, and provides suggested modifications to improve anchor performance. The data provided can be used to quantify anchor capacity, to guide anchor selection, to improve the understanding of anchor behavior, and to guide the formulation of empirically and theoretically founded schemes to define anchoring capacity. Although the number of tests performed on each anchor during the recent anchor tests in sand and mud was limited, the repeatability of the data was excellent and correlations with previous NCEL tests provided added insight into the specific behavior of the tested anchors and into general anchor and chain behavior. Data for the Two-Fluke Balanced, STATO, MOORFAST, BRUCE Twin-Shank, STEVFIX, PRISMA, and WISHBONE anchors are presented principally as plots of anchor penetration, holding capacity, and shank pitch and roll as functions of anchor drag distance.

N-1636
Dewatering Cofferdam for the TRIDENT Submarine Drydock, Jun 1982, J. B. Forrest, ADA120023

The dewatering cofferdam for the TRIDENT nuclear submarine drydock at Bangor, Washington, presented many challenges. These included water depths up to 25 meters, artesian pressures 10 to 13 meters above mean sea level, difficult pile driving conditions, and the potential for seismically induced liquefaction of the fill in the cofferdam cells. Design ground motions of 0.15g dictated that fill densities exceed 75% density index. Deep compaction was achieved using a large vibratory probe. Inclinometer, strain gage, and optical survey measurements on the sheet piles and extensive piezometric data were obtained. Significant observations were that (1) deep cell compaction can

markedly increase fill density without increasing lateral cell pressures unduly, and (2) maximum interlock tension may be well below the one-quarter height of exposed sheeting as often assumed in design.

N-1637
Desert Water Supply, Jun 1982, J. Crane, ADB068233L

Water supply, treatment, storage, and distribution requirements were assessed in relation to national Marine Corps structures and hypothetical desert scenarios to determine required capabilities and potential shortfalls in current assets. Pieces of equipment currently in inventory or in the procurement cycle were found to be suitable considering the Marine Corps mission and deployment methods. Shortfalls were identified, and recommendations were provided concerning transfer hose, beach intake well points for reverse osmosis treatment, thermal protection for storage and distribution equipment, and ground water acquisition capabilities.

N-1638
100K Propellant Anchor Technology Transfer - Diego Garcia Fleet Mooring Installation, Jul 1982, J. C. Miller, ADB068192L

The Naval Civil Engineering Laboratory (NCEL) has been developing and operating propellant embedded anchors since 1968. Beginning in 1979 this technology was transferred to a field division of the Naval Facilities Engineering Command (NAVFAC) to support fleet operations. In 1980-81, this technology was used to install eleven fleet moorings in the coral bottom of the Lagoon at Diego Garcia B.I.O.T. Ninety-seven anchors were fired; eight failed to hold the required proof load, 100,000 or 150,000 pounds, and one failed prior to proof loading. Data on all shots are presented along with a discussion of operating procedures. The report also documents the technology transfer process.

N-1639
Test and Evaluation of the Magnograph^{TM} Unit - A Nondestructive Wire Rope Tester, Jul 1982, L. D. Underbakke, H. H. Haynes, ADA124267

The nondestructive wire rope test device, a unitized AC/DC Magnograph, was tested for operational characteristics prior to acquisition by Naval field activities and start of inspection programs. The Magnograph was tested for loss of metallic area (LMA) and local fault (LF) detection accuracy. Wire ropes 1/2, 3/4, 1-1/8, 1-1/2, 2, and 2-1/2 inches in diameter were tested on a wire rope test track to find the accuracy of the unit. Two mining wire ropes, guy wires of a 1,000-ft-tall tower, and wire rope for 400-, 250-, and 30-ton cranes were used to determine operational characteristics of the Magnograph.

N-1640
An Economic Analysis of Earthquake Design Levels, Jul 1982, J. M. Ferritto, ADA120024

This report presents data on the cost of increasing the seismic design strength of buildings for three strengthening concepts: moment frame, braced frame, and shear wall. Damage is related to drift and acceleration of key elements of the structure. A damage matrix was constructed relating damage to design level and applied loading. An economic analysis was performed evaluating cost of strengthening, the present worth of expected damage, and the probability of site acceleration levels.

N-1641
Operating and Maintenance Experience with a 6-kW Wind Energy Conversion System at Naval Station, Treasure Island, California, Jul 1982, D. Pal, ADA119389

This report describes in detail the experience gained and lessons learned from the 6-kW grid-integrated Wind Energy Conversion System (WECS) demonstration at Naval Station, Treasure Island, San Francisco Bay. The objective of this demonstration was to develop operating experience and maintenance information on the 6-kW WECS using a combination of permanent magnet alternator with a line commutated synchronous inverter. The on-site measurements conducted during the demonstration indicate that the WECS site has annual average windspeeds of about 8 to 10 mph. The test results to date indicate a satisfactory performance of the WECS except for two failures involving arcing at the electrical terminals located on the yaw shaft. Due to wind characteristics encountered at the site, the performance data collected to date are at windspeeds of 20 mph or lower. For evaluating the WECS performance at all windspeeds, location at a windier site with annual average windspeeds of 14 mph or higher is recommended.

N-1642
An Economic Evaluation of Alternative Methods of Utilizing Available Landfill Gas to Cogenerate Power at NAS Miramar, Aug 1982, C. A. Kodres, AD

The Naval Air Station at Miramar contains the largest active sanitary landfill in San Diego County. It is estimated that the anaerobic decomposition of the organic refuse in this fill is producing sufficient methane to completely satisfy the energy requirements of the base if some means can be found to efficiently utilize this gas as a fuel. An economic evaluation of alternative methods of employing the landfill gas is presented. Among the alternatives examined is the use of the methane as a gas turbine fuel to cogenerate both electricity and steam.

N-1643
Thermal Conductivity of Weathered Polyurethane Foam Roofing, Sep 1982, D. A. Zarate, R. L. Alumbaugh, ADA128767

An investigation of the decay in the thermal conductivity of polyurethane foam (PUF) with time is presented. The polyurethane foams studied included samples removed from sprayed PUF roofing systems on structures at Guam, Marianas Island; Subic Bay, Republic of the Phillipines; Denver, Colorado; Clifton, New Jersey; and Port Hueneme, California. Thermal conductivity results closely agree with those predicted for a foam aged at 25°C in a controlled atmosphere. Results also indicate that the foam can provide good insulation characteristics in spite of poor application.

N-1644
Improved Field Performance for Reverse Osmosis Systems, Sep 1982, T. A. Kuepper, ADA124244

The report describes two test programs: the first one involved the physical cleaning of reverse osmosis (RO) membranes by means of flow surging and ultrasonic cavitation. The objective was to clean RO membranes in situ without using chemical additives. It was shown that ultrasonic cleaning is an effective method for removing ferric oxide, calcium carbonate/sulfate scale, and bentonite clay deposits from individual pieces of RO membranes. However, ultrasonic cavitation was not effective when applied to RO membranes in a spiral-wound configuration. Flow surging proved to be an effective method for cleaning spiral-wound RO modules in the preliminary test program conducted. A second test program involved the evaluation of a tubular fabric filter which has the potential of replacing conventional mixed media filters with substantial weight and filter housing area savings. During the test program the filter removed over half of the turbidity of the feedwater used without any chemical additives and could be cleaned intermittently by backwashing.

N-1645
An Automatic Pump Control for MARCORPS AAFS/TAFDS Pump Sets, Sep 1982, J. Moreland, ADB070800L

An automatic pump control has been developed for Marine Corps POL pump sets. The automatic pump control is designed to increase Amphibious Assault Fuel System fuel throughput while reducing manpower and equipment requirements at pump sets deployed for cross-country transfer of bulk fuel. The Tactical Airfield Fuel Dispensing System will benefit from the automatic pump control because of reduced operator skill level and improvements in personnel and equipment safety.

N-1646
Summary Report of Partial Validation of the Surfzone Transition Analytical Methodology Using the Surfzone Test Vehicle, Sep 1982, J. Miller, ADB070930L

Results from field tests of the full-size tracked surfzone test vehicle (STV) at two sandy beach/nearshore sites were used to investigate some key vehicle performance prediction relations in the trafficability submodel of the computerized surfzone transition analytical methodology (STAM). Analysis of the STV test results demonstrated that STAM equations for predicting the drawbar pull and total motion resistance of tracked vehicles are adequate and, in fact, slightly conservative for nearly all coarse-grained soil/tracked vehicle/ vehicle submergence conditions. Finally, suggestions were presented for needed model and prototype testing to validate prediction relations in STAM's other two submodels--the water force calculations and vehicle stability submodels--as well as prediction relations in yet unvalidated parts of STAM's trafficability submodel (primarily relations for obstacle override and for tracked vehicle operation in fine-grained soil nearshore areas).

N-1647
Microbiological Defacement of Navy Buildings, Oct 1982, R. W. Drisko, T. B. O'Neill, J. R. Moses, ADA124245

A survey was made of mildew problems at selected Naval activities in Hawaii and the Western Pacific. A list of factors affecting mildew growth was developed along with recommended practices to control the growth. A list of EPA-approved mildewcides is presented.

N-1648
Longevity of Propellant-Embedded Anchor Downhaul Cables: Initial Tests of Rope and Chain, Nov 1982, D. B. Jones, ADB073717L

The propellant-embedded anchor is a projectile that is driven vertically into the seafloor by a propellant charge in a gun. Anchors with nominal capacities of 10, 20, and 100 kips (45, 90, and 450 Newtons) have been developed. The downhaul cable is the length of line that connects the buried anchor to the rest of the mooring leg. The service life of this line is controlled by the varying degrees of corrosion, abrasion, and fatigue to which it is subject. Operational experience has provided little information on the service life of wire-rope downhauls, the only kind used thus far.

Laboratory tests were initiated to identify resistant downhaul cable materials. In these tests, the degrading processes in a seabed of quartz sand were simulated. For wire-rope specimens, loss of material through abrasion appeared to be important; however, failures occurred because of bending fatigue, compounded by corrosion. Nylon-rope specimens with and without surface coverings failed through external abrasion; a polyurethane sleeve provided the best abrasion protection.

Firing tests of 7/8-inch chain downhauls, proposed for the 10- and 20-kip anchors, showed that the chain can withstand the large acceleration experienced during firing of the projectile. However, the use of chain requires redesign of the projectile to balance the inertial load.

N-1649
A Model for On-Offshore Sediment Transport in the Surfzone, Dec 1982, J. A. Ballard, ADA124235

An energetics-based surfzone sediment transport model is evaluated for its ability to predict on-offshore sediment movements using nearshore sediment transport study current meter and beach volume measurements. The magnitude and distribution of pertinent wave velocity moments are also evaluated from the same data set. The latter were found to be linear functions of the significant wave height. Results of the study showed that the current meter data were of insufficient length to evaluate the sediment transport model's validity. A simplified version of the model coupled with estimated wave velocity moment regression equations was found to mimic observed beach volume variations as a function of wave height.

N-1650
Marine Corps Cold Weather Water Supply, Jan 1983, T. A. Kuepper, ADB073370

The Cold Weather Water Supply report defines cold weather regions and discusses water supply methods and equipment in terms of the following categories: detection, acquisition, treatment, storage, and distribution. Current and future water supply capabilities are examined and evaluated and specific recommendations are presented within the five water supply categories.

N-1651
Temperature Determination in Hush House Augmenter Tube With Multi-Colored Temperature-Indicating Paints, Dec 1982, E. L. Correa, ADB073716L

Temperature-indicating paints were used to determine if overheating temperatures occur in the liner plates in a hush house augmenter tube during in-frame engine testing of the F-14 aircraft. Several midheight stations along each side of the augmenter tube, prepared with a predetermined array of these paints, were subjected to the high temperature exhaust gas from an F-14 aircraft engine while in afterburner. During these tests the temperature peaks were found to be extremely sensitive to the longitudinal alignment of the F-14 aircraft to the centerline of the augmenter tube. Slight yaw misalignment of the aircraft resulted in peak temperatures as high as 1,350°F resulting in incandescence of portions of the liner plates. Straight alignment of the aircraft yielded peak temperatures of 1,000°F. This investigation also showed that use of temperature-indicating paints can be a practical and valuable technique for surface temperature measurement in a hot gas environment.

N-1652
Nonlinear Structural Analysis of a Large Aluminum Arch Rib, Jan 1983, T. A. Shugar, ADB073715L

A static, geometrically nonlinear structural analysis of a large aluminum alloy arch rib is described. The arch rib is the primary structural element in the design of a relocatable hangar for the Navy P-3 aircraft. Three load cases are included: an 80-knot wind load, a 40-psf symmetrical snow load, and a 40-psf partial snow load. The structural model consists of 47 straight beam elements and 48 nodes, and both a pinned end condition and a fixed end condition were analyzed. The nonlinear analysis was conducted with ADINA, a general purpose structural analysis computer program.

The symmetrical snow load was found to be the most severe load case. The nonlinear load/deflection behavior of the arch rib exhibited load softening behavior for snow loads and load-hardening behavior for wind load. Maximum deflections were on the order of the depth of the arch rib section, and maximum fiber stresses were less than 65% of the yield stress for the aluminum alloy material. The aluminum arch rib structural design is shown to be satisfactory as contrasted with a previous compound fiberglass arch rib design which did not sufficiently limit in-plane deflection.

N-1653
Water-in-Oil Emulsion as a Boiler Fuel, Jan 1983, T. T. Fu, ADA128773

Extensive tests have been conducted in an in-service boiler to determine the measurable benefits of firing water in no. 6 oil emulsions. Emulsions of 3, 6, 9, and 12% water concentrations have been fired during normal boiler operations. Although the emulsions could be fired satisfactorily without modifications to boiler equipment, the test results show that improvements, if any, in overall boiler efficiency or emissions were ambiguous.

N-1654
Sulfur Oxides Control Burner, Jan 1983, D. E. Williams, ADA128772

A new approach to burning coal in industrial-size boilers without being constrained by the sulfur content of the fuel was investigated. Coal combustion with the injection of a lime sulfur sorbent was evaluated using an equilibrium combustion computer program. Subsequent experimental work with a flame tube apparatus demonstrated that lime does react effectively with hydrogen sulfide in a low temperature, fuel-rich flame. Applications for this approach include both existing boilers designated for other fuels and new boilers designed for coal firing.

N-1655
A 20-kW Wind Energy Conversion System (WECS) at the Marine Corps Air Station, Kaneohe, Hawaii, Jan 1983, D. Pal, ADA128761

This report describes the field evaluation of a 20-kW wind energy conversion system (WECS) installed in September 1978 at the Marine Corps Air Station (MCAS), Kaneohe Bay, Hawaii. The wind turbine generator chosen for the evaluation was a horizontal-axis-propeller-downwind rotor driving a three-phase, self-excited alternator through a step-up gear box. The alternator is fed into the base power distribution through a three-phase, line-commutated-synchronous inverter using SCRs. The site has moderate wind conditions with an annual average windspeed of 12 to 14 mph, and the WECS turbine has a relatively high (29 mph) rated windspeed. The 20-kW WECS system was primarily designed to obtain operating experience with, and maintenance information on, a 20-kW-sized WECS. This report describes in detail the experience gained and lessons learned during the field evaluation.

N-1656
Experimental Polyurethane Foam Roof Systems - II, Jan 1983, R. L. Alumbaugh, J. R. Keeton, E. F. Humm, ADA126315

An experimental roofing installation is described in which polyurethane foam (PUF) was spray-applied directly to metal Butlerib-type metal decks, the roof divided into five approximately equal areas, and the PUF protected with five different elastomeric coating systems. Three of the coating systems were damaged by hailstones about a year after installation; these systems were recoated within 3 years of the initial installation. The current coatings include two of the original coating systems--a plural component silicone and a single component silicone--and those applied over the three systems damaged by hail--a single component silicone, an aluminum filled, hydrocarbon-extended catalyzed urethane, and a catalyzed urethane. The performance of these five PUF systems over a 7-year period is reported. The temperature distributions throughout the roof systems are described. The decay in the thermal conductivity of the PUF roof over a 5-year period is presented, and the energy savings realized by foaming the roof are presented.

N-1657
The Remote Data Recorder: An Onboard Recorder for the Magnograph™ Nondestructive Test Wire Rope Sensor Head, Feb 1983, L. Underbakke, AD

The remote data recorder allows the sensor head of the nondestructive test wire rope inspection device, the Magnograph™, to be used without being hardwired to the electronic recorder module. This allows the inspecton of wire ropes in remote, hazardous, or inaccessible locations. This report describes the portable data recorder and presents the results of tests performed to evaluate its effectiveness in inspecting wire ropes that are inaccessible to close visual inspection.

N-1658
Control Strategies for Reducing Heating, Ventilating, and Air Conditioning (HVAC) Energy Consumption in Single Buildings, Mar 1983, R. E. Kirts, ADA128748

This report presents a discussion of the most common control strategies and equipment used to reduce the amount of energy consumed by heating, ventilating, and air conditioning (HVAC) systems. Two basic concepts are discussed: (1) bringing the existing control system up to design specification while retaining the original control strategy, and (2) employing a new control strategy. The new control strategies analyzed are scheduled start-stop, day-night setback, optimum start-stop, dead band control, duty cycling, demand limiting and load shedding, economizer and enthalpy cycles, scheduled temperature reset, chiller control and chilled water reset, boiler control and hot water temperature reset, and condenser water temperature reset. Recent developments in HVAC control system hardware, such as pneumatic systems, electropneumatic systems, digital-electronic systems, and microcomputer-based control systems, are also discussed. The strategies are described and compared to each other in terms of cost effectiveness. The BLAST computer program is used to evaluate the various control strategies. The results illustrate the energy-saving potential of simple strategies, such as night and weekend setback and scheduled start-stop, which are inexpensive to implement and should be installed in most buildings. The most complex strategy is not necessarily the most effective due to the interactions between the building, climate, and HVAC system.

N-1659
A Parametric Examination of the Heat Recovery Incinerators at NAS Jacksonville, Mar 1983, C. A. Kodres, ADA128764

A mathematical model is developed to simulate the operation of the heat recovery incinerators at NAS Jacksonville. The model is used to conduct a parametric examination of the facility. Airflows, including leakages, are the dominant parameters affecting operation of the HRI. Because of poor airflow control, and partly because of air leakage, the Jacksonville HRIs rarely operate in the starved air mode they were designed for.

N-1660
Development of High-Capacity Expedient Anchors for Shoreside Military Application, Mar 1983, K. Rocker, ADB073727L

This is an interim report on the development of equipment and procedures for installing plate embedment anchors of known capacity under field conditions. The report lists Navy needs, discusses historical solutions, and recommends a procedure for sizing and placing anchors using nonspecialized personnel and man-portable equipment. The report summarizes the equipment evaluation and the remaining work required on equipment and analytical procedure development.

N-1661
Test and Evaluation of the MT 75 Rope Tester - A Hand-Held NDT Wire-Rope Inspection Device, Mar 1983, L. D. Underbakke, ADA128790

The nondestructive wire rope tester, MT 75, was investigated, tested, and evaluated in order to fill the gap between the hand-held rag inspection and the large unitized AC/DC wire rope inspection device. The MT 75 can provide better information on the condition of the wire rope than can be obtained by using the "rag and visual" inspection method.

N-1662
Measurement of Full-Scale Current-Induced Forces and Yaw Moments on a Destroyer, Apr 1983, P. A. Palo, ADB076808L

This report summarizes full-scale tests on the current-induced forces and yaw moments on two World War II destroyers. The vessels were moored in the open ocean with bow and stern lines, and measurements were taken of the mooring line tensions under various wind, wave, and current excitations at different angles of attack. The resulting current load data were analyzed using three independent methods and are considered reliable. Analysis of the data shows that the stern appendages had a large effect on the total loads, which would be increased if propellers had been present.

The data are the first known reliable data for the validation of state-of-the-art current load methodologies. An estimate was also made of asymptotic fouling resistance, which is the first known. Measured wind loads are also compared to expected values.

Because the resulting data apply only to a single, badly fouled destroyer without propellers excited by low (up to 0.4-knot) currents in deep water, it is necessary that further current load testing be performed to adequately validate state-of-the-art methods for calculating current-induced loads for arbitrary vessels and water depths.

N-1663
Utilizing the Optimum Start/Stop Control Strategy for Heating Naval Civil Engineering Laboratory, Apr 1983, I. Sanchez, ADA129257

NCEL has successfully implemented a single-building controller that measures indoor and outdoor temperatures to determine optimum times to start and stop steam heat. Significant energy and dollar savings have been demonstrated. Operating experience with the controller and details on its hardware and software are presented in this report.

N-1664
An Investigation of the Indirect Boundary Element Method in One- and Two-Dimensional Elastostatics, May 1983, T. A. Shugar, J. V. Cox, ADA133142

This report presents a study of the indirect boundary element method and its potential advantages for solving one-and two-dimensional linear structural/stress analysis problems. The theoretical formulation of the indirect boundary element method is illustrated first by developing the framework of one-dimensional beams resting on elastic foundations, and then extending the same concept to the framework of two-dimensional plane stress or plane strain elastostatics. Computer programs are written both in BASIC and FORTRAN that numerically implement the theoretical formulations for the one-dimensional application. The program for the two-dimensional application is written in FORTRAN. Accuracy of the indirect boundary element solution is assessed through comparison with theoretical solutions and with solutions from the alternative, direct boundary element method. With regard to edge effects, the indirect boundary element method faired better than the particular direct boundary element implementation that was available for comparison. The results pertaining to the accuracy of the indirect boundary element method to correctly capture stress gradients were very encouraging, even for the constant stress elements employed. The results suggest that the method may be a very economical analysis tool for determining stress concentration factors in elastostatics. Because the necessary input data requirements are less and smaller matrices result, the boundary element methods are more suited to small computers, thus enhancing the use of the methods as effective stress analysis tools.

N-1665
Low Cost Material Testing for Hush House Dry Augmentors - Phase I Results, May 1983, E. Correa, ADB074245L

Less expensive (but comparable) substitute acoustic pillows and liner plates were evaluated for use in aircraft hush houses. Four trial acoustic pillows made of lower cost "Thermal Insulating Wool" (fiberglass) and four trial liner plates made from type 409 stainless steel were tested. Only limited operational time has accumulated on these trial materials. However, on the basis of preliminary findings, both materials have functioned satisfactorily in the lower temperature regions of the augmenter tube, but not well in the higher temperature regions. The fiberglass pillow filler material has a potential for only a 1% pillow cost savings with a markedly reduced safe operating temperature. The liner plate material has a cost saving potential of 12%, but also has less attractive mechanical properties that require additional evaluation prior to recommendation for design.

N-1666
Computer Simulation of Buildings Cooled by Natural Ventilation, May 1983, S. Ashley, ADA133107

This report presents general information covering the experimental and theoretical basis used to develop the computer simulation of natural ventilation cooling of buildings. Computer input and output and an application example are included. The computer program predicts ventilation rates, mean interior air speed and direction of air flow, interior temperatures, and interior and exterior effective temperatures for a given set of conditions. These conditions are: wind velocity, ambient air temperatures, air leakage characteristics of openings, the mechanically induced air flow rates, type of building construction, interior heat loads, and the number of people in the building.

The application of this computer model includes the study of the natural ventilation performance of a building, the influence of natural infiltration on mechanical ventilation systems, and the study of smoke in the event of a fire.

N-1667
Development & Testing of a Single Point Mooring (SPM) Fuel Buoy for Amphibious Logistic Support, May 1983, G. Bretz, ADB076858L

Increased Marine Corps fuel consumption rates, coupled with the retirement of the Navy's small tankers, demanded a change in the Navy's fuel supply capability. The SPM fuel buoy, utilized in conjunction with commercial fuel tankers, was developed to provide this capability. The SPM buoy is a lightweight (less than 70 tons), easily installable version of the commercial catenary anchor leg buoy system. It will be used to deliver in excess of 1 million gallons of fuel per day from up to 10,000 feet offshore. The major stages in the development of the SPM buoy system as reported herein include: conceptual design, model studies, final design, construction, acceptance testing, full scale development testing (DT-II), and

full scale developmental testing to support the first major production decision (TECHEVAL). The engineering results for each of these developmental stages are presented. The installation of the SPM fuel buoy in its present stage of development represents a complex, highly sophisticated construction project. Testing has shown that this project is within the capabilities of an Amphibious Construction Battalion utilizing existing unit assets.

N-1668
Summary of DT-II Tests for COTS Temporary Container Discharge Facility, May 1983, J. J. Traffalis, G. Bretz, ADB076834L

A series of controlled tests was conducted with a Manitowoc 4100 Series 3 ringer crane to obtain technical data in order to prepare specifications for future TCDF crane procurements. The purpose of this report is to abstract and reference all preliminary reports into one summary report covering the COTS-TCDF DT-II test program.

N- 669
Charts for Predicting Response of a Simple Spring-Mass System to Bilinear Blast Loads, Jun 1983, J. S. Hopkins, ADB077257L

Charts are presented for rapid prediction of the dynamic response of a simple spring-mass system subjected to a bilinear blast load. Such a loading represents the design blast loading on either the exterior or interior faces of a structure from an explosion located either inside or outside the structure. Predictions from the charts are within 10% of exact solutions for most applications. The charts are also useful in identifying the relative importance of design parameters on dynamic response and the range of parameters for which simple approximations are justified without introducing significant prediction errors.

N-1670
Axial Tension Testing of Horizontal Connectors for Use With Intermodal ISO Containers, Jul 1983, R. H. Seabold, B. Posadas, ADA133670

The results of a static test to determine whether a Line Fast Corporation Tandemloc Connector meets the tensile requirements for use with ISO containers in the Marine Corps Container System and the NMCB TOA Container System are presented. Sixteen connectors were tested. The maximum applied forces were measured, recorded, and then compared with the rated capacity. The connector met the tensile requirements and should be qualified for use with both container systems.

N-1671
An Economic Analysis of Earthquake Design Levels for New Concrete Construction, Jul 1983, J. M. Ferritto, ADA133144

This report presents data on the cost of seismic strengthening for a new concrete structure for two strengthening concepts: moment frame and shear wall. Damage is related to drift and acceleration of key elements of the structure. A damage matrix is constructed relating damage to design level and applied loading. An economic analysis is performed evaluating cost of strengthening, the present worth of expected damage, and the probability of site acceleration levels.

N-1672
1982 Inspection of Experimental Marine Pilings at Pearl Harbor, Hawaii, Jul 1983, T. B. O'Neill, ADA133149

The Navy is considering alternative wood preservatives that are environmentally acceptable. In order to determine the effectiveness of wood preservatives in the marine environment, the Naval Civil Engineering Laboratory (NCEL), in cooperation with industry, installed pilings with test preservatives in Pearl Harbor, Hawaii, in 1963 through 1966 and has observed and evaluated the preservatives. Certain chemicals, such as the chlorinated hydrocarbons, chlordane, and dieldrin, have demonstrated outstanding preservative qualities; the use of such preservatives, however, in the marine environment is subject to EPA restrictions. Basic zinc sulfate is an environmentally acceptable preservative that appears to show promise; its effects on the mechanical properties of wood should be more thoroughly investigated.

N-1673
Fluidized Bed Air-to-Air Heat Pump Evaporator Evaluation, Jul 1983, J. L. Ashley, ADA133072

Frost formation of air-to-air heat pump evaporator surfaces reduces unit efficiency and restricts geographic application. The use of a fluidized bed heat exchanger as an air-to-heat pump evaporator was investigated to determine if frost accumulation could be eliminated. Experimental investigations were conducted and the following results obtained: (1) frost accumulation was insignificant with fluidized bed temperatures below 32°F and (2) moisture accumulation from condensation resulted in unstable fluidized bed operation when the fluidized bed temperature was above 32°F. Several concepts--maintenance of bed temperature below 32°F, reverse refrigerant flow, air-dry bed, nonadhering bed material, and ultrasonics--to solve the moist bed problem were evaluated, with no practical solution being developed. The use of a fluidized bed heat exchanger with air-to-air heat pump evaporators was determined not feasible.

N-1674
Utilization of Navy-Generated Waste Oils as Boiler Fuel - Handbook of Guidelines and Field Survey Results, Jul 1983, T. T. Fu, C. Semien, ADA133717

This technical note provides information for a variety of users at different levels of management and operation. Part 1 contains background information on waste oil generation and a survey of waste oil disposition. Part 2 provides pertinent information to Public Works Officers and planners. Topics include: source of waste oil, a survey of disposition of waste oil, restrictions on use as fuel, boiler fuels, air quality considerations, and economics. Part 3 provides procedural information to operators using waste oil as boiler fuel. Waste oil handling, pre-burning treatment, burning methods, equipment modifications, and operational requirements are discussed. Part 4 consists of: a comprehensive survey of the potential for utilizing waste oil by Navy/Marine Corps activities and a compilation of the reported experience of waste oil users.

N-1675
Vulnerability of High-Efficiency Solid State Fluorescent Ballasts, Aug 1983, W. Weir, ADB077253L

High-efficiency, solid state fluorescent ballasts are more vulnerable to the transients and surge voltages present in low-voltage AC power circuits than their electrical ancestors of the 1960s; thus, an investigation was conducted to determine the vulnerability of these more efficient devices to electrical transients and, if appropriate, to determine what protection would be needed to prevent future failures. Three sample ballasts were procured and tested using the Institute of Electrical and Electronic Engineers (IEEE) Standard 587-1980 as a reference. Tests were made to determine vulnerability for normal mode injection and for three variations of common mode injection. Both the THOMAS and TRIAD ballasts passed the IEEE Standard 587-1980 Category A tests; therefore, no additional transient protection should be required. The EE TECH ballast failed, as it could only withstand surges up to 4 kV. Many facilities, however, do not experience transients this high, so if EE TECH ballasts have been

installed and are working properly, there is little cause for alarm. But until such time as the EE TECH ballasts have been certified to pass the IEEE tests, it is recommended that General Electric V130LA10A metal oxide varistors be installed for ballast protection.

N-1676
Plastic Composite Panel and Grid-Reinforced Soil Repair Method for Bomb-Damaged Airfield Pavements, Aug 1983, P. S. Springston, R. Claxton, ADB077668L

This report documents the development and traffic testing of a panelized matting system fabricated of fiberglass-reinforced polyester (FRP) resin. An FRP panel system was developed wherein individual panels could be rapidly linked together to form a foreign object damage (FOD) cover for use in rapid runway repair or expedient runway surfacing. Ten panels were fabricated and assembled to form a 27- by 30-foot crater cover, which was used in conjunction with an aluminum, honeycomb, grid-reinforced sand base for a simulated bomb crater repair. The simulated crater test section was traffic tested with 10, 72, and 100 coverages of C-130, F-4, and C-141 load cart traffic, respectively. The FRP panels sustained all applied traffic without damage. As a result, the FRP panel system is recommended as a crater repair cover for crushed stone and grid-reinforced sand repair methods. The FRP/sand grid system is recommended for repair of runways subjected to C-130 and F-4 operations. Research of a modified FRP/grid repair system using a thin, FRP reinforcing membrane at the sand/debris interface should be conducted.

N-1677
Diver-Operated Sediment Excavation Tool, Sep 1983, H. Thomson, ADA133640

Underwater construction tasks frequently require the removal of seafloor sand and sediment. An experimental sediment excavation tool was fabricated from commercially available and specially designed components. The diver-operated tool combined a jet-eductor, a jet nozzle and a hydraulically powered sump pump into a jet-dredge tool to increase excavation rates, reduce reaction forces, and improve water visibility in jetting operations. A later version included multi-jet nozzles rather than a single jet nozzle. Engineering tests of the experimental tool and all candidate components were conducted. The test results are presented in this document and show that the tool is effective. The next step in development is suitable engineering design for use by Fleet units.

N-1678
Installation of a Single-Building Energy Controller at the Public Works Center, Naval Weapons Center, China Lake, Sep 1983, K. J. Canfield, AD

Single-building energy controllers can be installed in many buildings to conserve energy. These systems can provide significant energy savings with limited investment. This report details the installation of a single-building energy controller in the Public Works Center building at Naval Weapons Center, China Lake, Calif. The controller was installed by NCEL and Public Works personnel in about 3 days, and is working very well. The reasons for the success are a reliable controller, a dedicated user, and the patience and cooperation of the building occupants.

N-1679
Thermal Energy Recovery in Gas Turbine Engine Test Cells, Nov 1983, C. A. Kodres, AD

The economics of thermal energy recovery in jet engine test cells is examined. A numerical model to simulate the test cell augmenter tube is developed. This model is employed to determine the feasibility of installing heat exchangers along with the augmenter or at the augmenter exit and using these heat exchangers to generate steam or electricity from the thermal energy in the jet exhaust.

In general, energy recovery is not practical. The exhaust is quickly diluted by the entrained augmentation air, decreasing temperature gradients necessary for heat transfer. Most test cells are used too infrequently to warrant the cost of the hardware.

N-1680
Navy-Lightered Pontoon Causeway Structural Analysis, Elevated Pier Facility, Nov 1983, F. R. Johnson, J. L. Sullivan, AD

This report documents the structural analysis of the elevated causeway system (ELCAS) for the Container Off-loading and Transfer System (COTS) for special application. These include lifting of 35-long-ton, 40-foot containers at a 40-foot operating radius from a lighter in the open sea and employing the elevated causeway in a harbor environment with a 40-foot water depth. The structural analysis confirms that the ELCAS can be used for the special application. However, additional interior piles are required on each pier head section.

N-1681
NCEL Ocean Platforms Seminar, Nov 1983, D. R. Shields, AD

The NCEL Ocean Platforms Seminar was held on 11-12 January 1983. Eleven experts, selected to represent the major disciplines relevant to ocean platforms, were invited to present papers and discuss R&D needs. The state-of-technology in ocean platforms was identified and R&D topics defined. This report provides the papers presented at the seminar and the conclusions from each participant concerning R&D needs.

N-1682
Diver-Installed Seafloor Fasteners, Nov 1983, H. Thomson, K. Rocker, AD

Underwater construction operations frequently require efficient and reliable seafloor fastening systems. New equipment and procedures for the installation of these systems by divers have been developed for use in soft coral and sand regions. Grouted fasteners proved to be stronger and more reliable than previous fastening systems in coral. In addition, the use of a newly developed grout dispensing tool proved to be an efficient and highly improved method for underwater grouting by divers. Seafloor fastening in sand was accomplished by plate embedment anchors driven into the seafloor by a hydraulic-powered jackhammer. Four sizes of anchors were driven at two underwater and one surfzone site. A pullout device was constructed to key the anchors, measure pullout load as a function of vertical travel, and to retrieve the anchors for reuse. The method for predicting plate anchor holding capacity and important parameters that affect capacity are discussed. Curves for predicting the short-term holding capacity of four small anchors driven to depths between 3 and 8 feet are presented for five types of sand seafloors. These data are recommended for estimating field anchor holding capacity. Test device pullout loads recorded for the installed anchors are reported and compared with pullout loads predicted for the unusual loading condition imposed by the test device.

N-1683
Underwriters Laboratories Fire Tests of Sprayed Polyurethane Foam Applied Directly to Metal Roof Decks, Dec 1983, R. L. Alumbaugh, S. R. Conklin, AD

The Naval Civil Engineering Laboratory has conducted extensive fire testing of sprayed polyurethane foam (PUF) roof systems applied directly to metal roof decks. Testing

was conducted at Underwriters Laboratories (UL) and the work was sponsored by the Naval Material Command and the Naval Facilities Engineering Command. The work was conducted in three phases with the first phase being directed toward PUF systems applied principally to standing seam metal decks, the second phase toward PUF on corrugated metal decks, and the third phase toward PUF applied to fluted metal decks.

The fire test program was most successful. Results showed that the PUF roof systems performed as well as, if not better than, the standard built-up roof system. This report provides details of the test program, the roof deck construction classifications that resulted from the tests, and a listing of over 100 PUF roof systems that are now classified under the three Roof Deck Constructions. These classified systems meet the fire safety criteria (specifically DOD and Navy criteria) and can be used on appropriate metal roof decks at Naval Shore Activities.

N-1684
Design Guidelines for Heating Aircraft Hangars With Radiant Heaters, Dec 1983, E. L. Correa, AD

An investigation was conducted on the use of radiant heaters to reduce the cost of heating aircraft hangars. Those best suited for space heating aircraft hangars were found to be the gas-fired, high-intensity, porous, refractory-infrared heaters. Radiant heaters provide increased thermal comfort for personnel while substantially reducing heating costs. Considerable fuel is saved by: (1) allowing a lower interior air temperature to be maintained while providing personnel comfort, (2) reducing heat stratification, (3) reducing fuel consumption with high efficiency burners, (4) reducing building heat loss, and (5) heating only occupied areas rather than the whole building. This report includes the principles of radiant heating in hangars, guidelines for optimum system design, and discussion of the physiological aspects of radiant heating. Cost analysis procedures are given for determining the cost-effectiveness of the radiant systems for comparison with other types of heating systems.

Four alternative means for utilizing WDF - adding incinerators, replacing boilers, modifying existing boilers, and making hybrid conversions - were considered for each class. Incineration and modification of existing boilers were emphasized. These alternatives appeared to be the most feasible ones for near-term implementation.

Problems encountered, system modifications required, and costs associated with the alternatives in the classes were defined as clearly as the accuracy of the available data would allow.

The major conclusions of this portion of the project are:

- Although it is technically feasible to adapt Navy energy conversion systems to fire WDF in one or more of its forms, the optimal form selected should be a site-specific total system.
- Near- to intermediate-term programs should probably continue to give first consideration to waterwall incinerators and to the cofiring of solid WDF in coal-capable plants because these options are the ones most completely developed and documented.
- Package incinerators and conversions of oil burning plants to fire a fluff form of solid waste fuel may be the options with the greatest potential for the intermediate term because waterwalls would be uneconomical in many small plants and because the majority of medium-sized oil-burning plants will not be converted to burn coal.
- Pyrolytic processes to produce gaseous and liquid fuels have not been sufficiently developed as yet to be specified for commercial operation. However, these forms of WDF have widespread potential applicability. If they (liquids in particular) become available, they could become the most cost-effective alternatives; using them would minimize the necessary modifications of existing energy conversion systems. Probably 5 years or more of development and testing will be needed before the future of pyrolysis is clear.

CR 80.003
Characterization of Navy Solid Waste and Collection and Disposal Practices, R. E. Freeman, A. G. Capps, Menlo Park, Calif., SRI International, Oct 1979, N00123-78-C-0868, ADA080322

The 1976 Resource Conservation and Recovery Act encourages the recovery of material and waste derived fuels to the maximum extent practicable at federal facilities, while complying with all state and local requirements as well. The Navy's Solid Waste research project is designed to identify and develop cost effective alternatives for meeting RCRA requirements. To meet this objective, an immediate need of the project was to quantify and characterize the recoverable material contained in the Navy waste stream and to compile information on how these materials are handled at typical Navy installations. The work was concentrated in two areas: compiling and analyzing available data about Navy solid waste composition and generation, and developing a set of realistic descriptions of typical Navy solid waste handling practices.

For waste composition and generator rate, data available from the NACWIS data base, including R^4 surveys conducted under the direction of the Naval Environmental Support Office (NESO), were compiled and analyzed. Navy facilities were listed in classes according to the amount of waste.

A simplified technique was examined for estimating quantities of the various recoverable resources generated by a Navy installation. This technique was tested against data obtained from the R^4 surveys mentioned above. The test was aimed at evaluating this relatively low-cost technique for possible use in augmenting Navy solid waste data to enable adequate field planning, selection, and preliminary sizing of Navy resource recovery systems. The technique requires a series of field observations of the volumes of waste generated and the waste's origin to estimate weight and composition. Once the bulk densities are thus derived, a few periodic volume observations will establish trends and cycles.

Existing information concerning current Navy practices for handling its solid waste was also derived from R^4 survey results obtained by the Navy. The information includes an indication of the type of personnel involved in the collection, the type of disposal methods used, useful life of landfill sites, and whether the landfill is on Navy property. The format in which the data are compiled was intended to enable the establishment of classes for collection and disposal methods and the indication of the number of Naval installations in each class.

This report also includes a brief analysis of how Navy and all other landfills will be affected by RCRA and the Safe Drinking Water Act (SDWA).

CR 80.004
Survey of Naval Port Fender Systems, Oxnard, Calif., VSE Corporation, Dec 1979, N00123-78-C-0391, ADA080564

A survey of Navy pier fender systems was conducted to evaluate the need for an RDT&E program leading to improved fender systems. Eighteen major activities were surveyed by mail, and on-site visits were made to activities in San Diego and Norfolk. The survey revealed:

a. An overall poor to fair condition for pier fender systems except where repair by replacement was being accomplished by large-scale projects.
b. A trend towards increasing costs and a declining quality of timber materials.
c. An overriding concern for the frequency and magnitude of damage by ships and craft.
d. A uniformity in problems, damage, and level of maintenance costs but a lack of uniformity in approaches to improvements and solutions.
e. Improvements in design and materials for timber pile fender systems in San Diego that may well be applicable to general purpose berthing at most other locations.
f. A need for concentrated, centralized work to improve camel and fender designs for submarines, carriers, and certain special use berthing.

Recommendations resulting from the survey include:

a. That no RDT&E effort is needed for general purpose berthing, but coordinated facilities acquisition and management efforts are needed to evaluate and implement certain specific improvements in timber pile systems.
b. RDT&E work in the near timeframe for dedicated submarine, CV/LHA, and certain special use berthing.
c. Initiation of a long-range study that looks to the time when wood products may not be available in the quantity and quality now depended upon for ship fendering.

CR 80.005
Waste Fuel Utilization in Existing Boilers on U.S. Naval Bases, H. I. Hollander, J. E. Broderick, J. G. Klett, Reading, Pa., Gilbert Associates Inc., Jan 1980, N00123-78-C-0868, ADA081261

The 1976 Resource Conservation and Recovery Act encourages the recovery of material and energy from waste to the maximum extent practicable at federal facilities while complying with state and local requirements. The Navy's solid waste research project is designed to identify and develop cost effective alternatives for meeting RCRA requirements. Additionally, to reduce Navy dependence on dwindling supplies of natural gas and fuel oil, the Navy has issued guidelines concerning the construction of intermediate and larger boiler plants requiring the capability to burn solid forms of fuel, including waste derived fuels as well as coal.

This report provides perspective on the ramifications of firing solid forms of waste derived fuel, separately or in combination with conventional fossil fuels for existing or new installations. The report is divided into two parts.

The first part presents a general discussion of typical characteristics of proposed waste fuels and the potential of utilizing these fuels in existing Navy boilers. The second part is a case study addressing a typical installation, and assesses the changes, capital costs, and potential problem areas that may be encountered in accommodating waste fuel firing.

Based on a site inspection at a three-boiler Navy plant, a conceptual retrofit layout was prepared of a practical system to cofire a waste fuel with the existing fossil fuel. The boiler plant selected routinely fired natural gas and fuel oil The waste fuel selected was a solid form of shredded waste (nominally 2-in. particle size with most glass, metals, and other inerts removed). The case study revealed that if the wastes were suitably prepared, approximately 60 TPD could routinely be consumed with 120 TPD total system capability based on the waste fuel providing 20% of the Btu input requirements during full load operation.

Base loading two retrofitted boilers at their design capacity and accommodating all steam load swings with the conventional fuel fired third boiler could displace more than 200 barrels of oil per day. At 35 cents per gallon, the annual savings in 1978 fuel costs would amount to over $1,000,000. Not only is there a potential fuel cost avoidance of more than $1,000,000, but there should also be some disposal cost avoidance, although counterbalanced at least in part by the costs for producing RDF. With the significant volume reduction of wastes to be landfilled, the effective life of the land area for this purpose will be materially increased.

CR 80.006
Application Potential of Energy Systems at Navy Sites, vol 1: Methodology and Results; vol 2: Navy Energy Siting (NES) Computer Program User's Manual, S. J. Anderson, M. D. Jackson, S. J. Chaump, Mountain View, Calif., Acurex Corporation, Oct 1979, N68305-78-C-0009, ADA081381 (vol 1), ADA081384 (vol 2)

Application of renewable and nonrenewable energy conversion technologies are forecast for the Navy's ten largest industrial locations and four smaller locations. Data are obtained from an optimization model that determines the least, life-cycle cost energy supply system for an industrial location. Optimal solutions were composed of integrated combinations of energy conversion technologies. Besides being more cost effective than status quo systems fired exclusively on fuel oil, the optimal integrated systems displace a significant percentage of fuel oil.

Energy conversion technologies that participate in the optimal supply systems for large Naval industrial locations include fluidized-bed coal combustion, cogeneration, oil-fired systems, with smaller contributions from refuse derived fuel systems. Oil-fired systems participate only in a peaking capacity wherever coal combustion is permitted. Otherwise, the status quo systems are forecasted to prevail.

Renewable energy conversion systems were not competitive in plant-size configurations at nine of the ten large Naval industrial locations studied, Pearl Harbor being the exception.

CR 80.007
Study of Forced Entry Resistant Doors and Other Barriers for Openings into Secure Structures: Intermediate-Size Doors for Secure Structures, R. Munk, La Jolla, Calif., Science Applications, Inc., Feb 1980, N62474-79-C-5444, ADB048843L

Functions requiring the use of secure facilities are identified and categorized. Door designs constituting the minimum acceptable deterents to forcible entry for the various categories of secure areas are identified. Recommendations are made regarding the selection of doors for secure facilities. Entry denial, containment of compromising signals, and design of compartmented security facilities are discussed.

CR 80.008
Study of Forced Entry Resistant Doors and Other Barriers for Openings into Secure Structures: Barriers for Secure Structure Penetrations, R. Munk, La Jolla, Calif., Science Applications, Inc., May 1980, N62474-79-C-5444, ADB048844L

The mandated requirements for barriers on windows and vents for the various secure facilities at Naval Shore Establishment installations are identified and compared. The penetration delays provided by the various barrier designs are documented. Recommendations are presented relating to windows and vents in secure structures.

CR 80.009
Study of Forced Entry Resistant Doors and Other Barriers for Openings into Secure Structures: Ordnance Structure Doors, R. Munk, D. Warne, La Jolla, Calif., Science Applications, Inc., May 1980, N62474-79-C-5444, ADB048845L

Doors used on earth covered magazines and other arms, ammunition, and explosives (AA&E) storage structures are described and categorized on the basis of the penetration delay provided when subjected to attacks using various classes of tools. Design features that produce susceptibilities to forcible entry are identified. Factors to be considered in the design of penetration resistant doors are identified.

CR 80.010
Architectural Planning for Crime and Loss Prevention as Applied to Major Hospital Complexes, G. P. Morse et al., Silver Spring, Md., George P. Morse and Associates, Apr 1980, N68305-78-C-0046, ADB047419

Concepts are presented for the reduction of crime related losses in Naval hopitals. Security design techniques which should be introduced prior to construction are discussed and recommendations made. Loss prevention management and security equipment are also discussed.

CR 80.011
Validation of a Freezer Concept for a Desalination Unit, Andover, Mass., Concentration Specialists, Inc., Apr 1980, N68305-78-C-0021, ADA085612

Validation of a smooth-tube, indirect-contact freezer concept was conducted toward inclusion in the design of a modular 20,000-gpd freezing desalinator for use at Naval Advanced Bases. A 500-gpd model freezing desalinator consisting of freezers, crystal growth tank, wash column, melter, and refrigeration system was used to test several flow schemes and freezer configurations having either three or five concentric tube freezer elements. Simplicity in operating mode coupled with low pressure drop (low pumping costs) and nigh ice production rates (high heat transfer coefficients) was sought.

To provide continuous operation, each of the freezer elements was periodically defrosted while the other elements were refrigerated. Brine was recirculated between the paralleled freezer elements and a crystal growth tank. Ice crystals accumulating at the top of the crystallizer were washed and scraped into an indirect contact melter prior to recombination with the brine stream from the wash column. The combined streams were then returned to the freezer/crystal growth tank recirculation loop.

Flow schemes were utilized with three and five freezer elements paralleled, with refrigerant forced circulation at two velocities, without refrigerant circulation, and with six different brine velocities from 6.0 fps to 18.9 fps. Reynolds' numbers varied from 11,600 to nearly 69,000. Tube side heat transfer coefficients were calculated to be from 784 Btu/hr-ft^2°F to 2,360 Btu/hr-ft^2°F with temperature differences between 6.8°C and 3.3°C, respectively.

Freezer element icing and plugging were encountered even at the highest Reynolds' numbers attained, i.e., >50,000. Defrosting was found to be required.

Positive results were obtained, in that ice in the form of a soft mass of small crystals similar to that produced in direct contact freezing processes was produced.

Inclusion of smooth-tube freezer design parameters developed in this effort into the preliminary design and sensitivity and economic analyses of a 20,000-gpd containerized freezing desalinator was not performed as originally planned, because it was judged that the fluidized bed freezer alternative would be less prone to freeze-up without significant increase in either pumping costs or system complexity.

CR 80.012
A Study of the Effects of Insulation Gaps on Building Heat Loss, Denver, Colo , Johns-Manville Sales Corp., Apr 1980, N68305-78-C-0056, ADA085222

The scope of the program included testing of a wall panel designated Type I and a second designated Type II. The Type I panel consisted of 2 x 4-inch studs spaced 16 inches on center and insulated with R-11 fiberglass insulation. Tests were conducted in a Guarded Hot Box operated in accordance with ASTM C236-66 (reapproved 1971). Thermal resistance values were determined at mean temperatures of approximately 45°F, 75°F, and 95°F. After these values were determined, insulation areas amounting to 5%, 10%, and 15% of that originally installed were cut out from the mid-height of the test metering area and the tests repeated at each condition. The cut outs were to simulate omissions or errors in installation of the insulation.

The second wall panel, designated Type II, was constructed to simulate 2 x 6-inch studs spaced 24 inches on center and insulated with R-19 fiberglass insulation. The test program duplicated that performed on the R-11 insulated wall in order to determine whether the greater thickness gave similar changes in measured heat flow with increasing insulation void areas.

The test results showed heat flows significantly greater than the percentage of gaps in the insulation. At 45°F mean temperature, the loss in thermal resistance was more than three times the gap percentage up to a 5% gap for 2 x 4-inch stud walls. For 2 x 6-inch stud walls, the loss was more than four times the gap percentage. For a 15% gap at 45°F, the loss increased to 38%.

CR 80.013
Development of a Physical Security Data Management System, 3 vols in 1, J. Caldwell, P. Benner, D. Solomonson, Santa Barbara, Calif., Mission Research Corporation, Nov 1979, DNA001-79-C-0182, ADA084840

Vol 1 presents a review of candidate manual information storage and retrieval systems and the identification of a manual system to suit the needs of CEL and its user community. Systems examined were (1) Edge-Notched Cards, (2) Peek-A-Boo Cards, and (3) Scan Match Cards. Each manual system is analyzed with respect to advantages and disadvantages for CEL needs.

Vol 2 is a user's manual describing the procedures for utilization of the Physical Security Data Management System developed for CEL. The Physical Security Data Management System is an information storage and retrieval system that was designed for in-house use by CEL staff. The manual presents (1) an overview of the Data Management System's hardware and software capabilities, including a description of the systems configuration, (2) user instructions for completion of the input sheet, (3) user instructions for entry of data into the on-line system, (4) description of batch outputs, and (5) user instructions for execution of data file searches in an interactive batch mode.

Vol 3 presents the system outputs of the Physical Security Data Management System. Three separate outputs are presented: the Master List, the Keyword Index, and the Keyword Count. Each individual record consists of a full bibliographical citation, a keyword list, technical annotations relating to physical security, and an abstract.

CR 80.014
Linings for Concrete Fuel Storage Tanks, T. A. Corboy, Temple City, Calif., Advanced Coatings and Chemicals, Jun 1980, N68305-78-C-0006, ADB053480L

A state-of-the-art survey of commercially available coating and lining materials was made. Thirty-five coating systems were applied to clean and/or oil-treated concrete specimens. These specimens, along with lining materials, were immersed in an aromatic-enriched aviation fuel plus a simulated microbial solution, or in a 50:50 mixture of diesel fuel marine and JP-5 plus a simulated microbial solution, for 90 days at 130°F. Four coating systems which had been applied to oil-soaked concrete had greater peel strengths than the present Navy system. Two lining materials directly exposed in the test fuels performed as well as the Pirelli Fix membrane which has a successful record of use by the Navy Fuel Systems Command.

CR 80.015
Development of a Seawater Hydraulic Vane Motor for Diver Tools, Annapolis, Md., Westinghouse Electric Corp., Oceanic Div., Apr 1980, N00123-78-C-1057, ADA084920

A compact efficient hydraulic vane motor capable of operating with pressurized seawater as the working fluid has been successfully developed for use with diver tools. The motor occupies a volume of 23 $in.^3$ and weighs less than 5 pounds. With 1,000-psi seawater at 6-gpm flow rates, the motor delivered 3.3 hp at 1,585 rpm with 80% overall efficiency. The motor operated for 50 hours without component failure. Results of the design and development effort are presented.

CR 80.016
Cargo Fire Hazards and Hazard Control for the Offshore Bulk Fuel System (OBFS), Norman, Okla., Energy Analysts, Inc., Jun 1980, N68305-79-C-0021, ADA087282

This study evaluates potential cargo fuel spills, spill fires, and equipment available to mitigate fuel spill hazards at an offshore bulk fuel supply installation. Potential cargo spill sources, probabilities, and volumes are calculated. Consequences of these spills assuming spill ignition are quantified. Existing fire protection equipment aboard tankers is evaluated to determine the ability of this equipment to control identified spill fire conditions. Where existing firefighting systems are found to be inadequate, additional fire mitigation systems are recommended. Logistic support, manpower, and training needed to maintain the recommended spill control systems are detailed.

CR 80.017
Study of Forced Entry Resistant Doors and Other Barriers for Openings into Secure Structures: Venting Provisions in Earth Covered Magazines, R. Munk, D. Warne, La Jolla, Calif., Science Applications Inc., Jul 1980, N62474-79-C-5444, ADB049261L

Vents constitute the weakest link in the physical security of earth covered magazines for conventional arms, ammunition, and explosives. The question as to whether or not vents were necessary in earth covered magazines was addressed in this study, which entailed a literature review and solicitation of expert opinions on the subject. While not totally conclusive, the results indicate that vents are not necessary for a very large part of the conventional stockpile; the study also reveals that removal of vents actually improves the thermal stability of earth covered magazines.

CR 80.018
Evaluating the SEADYN Model: Mooring Dynamics Experiment Five, D. B. Dillion, Washington, D.C., EG&G Washington Analytical Services Center, Inc., Jul 1980, N00014-78-C-0273. ADA082165

The computer model of ocean cable structures, SEADYN, was used to calculate the anchor-last deployment of the sixth mooring (experiment five) of the Mooring Dynamics Experiment (MDE) conducted in Hawaiian waters in 1976. Comparisons were drawn with measurements of configuration and tension made during the deployment. The SEADYN configuration correlated well with the experimental data when an anchor drag coefficient of 0.78 was used. This value was precalculated to produce the terminal velocity experienced in the MDE.

The MDE provided exceptionally detailed tension data at four points along the mooring. SEADYN reproduces the general features of these measurements with remarkable accuracy.

The SEADYN tension traces include spurious oscillations that mask details of the tension history. These oscillations are believed to result from the omission of material damping in the SEADYN algorithm. Inclusion of hysteresis in the material stress-strain function is expected to remove the oscillations.

Modeling the MDE mooring occurs in two steps. SEADYN is a general cable dynamics computer model using the finite element method. The SEADYN user is also modeler as he reduces the physical mooring to equivalent elements and spherical or cylindrical nodes. This requires considerable technical skills and intuition when, for example, the physical object at the node is a pile of sandbags on a pallet.

CR 80.019
Mooring Dynamics: Computer Models and Experiments at a Sixty Foot Scale, D. B. Dillon, Washington, D.C., EG&G Washington Analytical Services Center, Sep 1980, N00014-78-C-0273, ADA086854

The U.S. Navy Civil Engineering Laboratory is conducting a series of dynamic cable experiments in order to evaluate computer models of cable systems used in the ocean. The results of an experiment using 60-foot cables are compared to two computer simulations in this report. Other experiments at scales of 6 feet and 2,500 feet have been performed.

Three cases from the experiment conducted in the hydroballastics tank of the Naval Surface Weapons Center in 1976 are compared to the SNAPLOAD and SEADYN computer models. Two of the runs simulate the anchor-last deployment of a mooring; the third shows the relaxation of a mooring displaced laterally, then released.

The quality of the experimental data is evaluated by comparing each case to the static, elastic catenary equations at the start and finish of each run. The measured positions of points along the static catenaries are found typically to agree with the catenary calculations within 1% to 2% of the cable length. Tension measured at the fixed end typically agrees with the calculated value within about 12%.

The SEADYN and SNAPLOAD computer models are found to reproduce all the significant motion and forces observed in the experiment. The "handbook" drag coefficients programmed in these models allow the cable motion sometimes to lead the data, sometimes to lag behind. More specific coefficients must be used when the rate of the dynamic motion is critical.

Neither model included elastic hysteresis. The SEADYN program gave somewhat erratic tension values in the mooring line because tension waves were not damped by hysteresis. The SNAPLOAD model eliminated the tension variation through artificial damping.

CR 80.020 - Cancelled

CR 80.021 - Cancelled

CR 80.022
Assessment of the Morison Equation, Houston, Tex., Woodward-Clyde Consultants, Jul 1980, N68305-80-C-0007, ADA088185

A critical assessment of the Morison equation is provided. The Morison equation is used to calculate the loading on offshore structures due to ocean waves. The assessment covers both the original equation and the modifications currently in use by industrial designers. A review of the literature is provided.

It is concluded that the Morison equation provides an adequate design tool provided careful consideration is given to the selection of the fluid kinematic representation and the empirical coefficients. Improvements in the accuracy of the operation can be achieved through research leading to (1) improved descriptions of the sea state, (2) better representations of the water particle velocities and accelerations in combined wave-current flows, (3) improved quantification of the drag and inertia coefficients, and (4) inclusion of the fluid-structural interaction.

CR 80.023
Flue Gas Desulfurization at Navy Bases, Navy Energy Guidance Study, Phase IV, A. I. McCone, San Francisco, Calif., Bechtel National, Inc., Aug 1980, N68305-77-C-0003, ADA089146

A study of the availability, costs, and operating performance of industrial-sized flue gas desulfurization (FGD) systems for coal-fired boilers was performed for the Civil Engineering Laboratory at the Naval Construction Battalion Center at Port Hueneme, CA. A generic overview analysis showed that conventional soda liquor scrubbing offered lowest costs and highest performance when environmental permits can be obtained for disposal of liquid wastes. When wastes must be in solid form, the lowest costs are offered by conventional limestone, lime, and double alkali calcium-based throwaway processes. Several processes still under development were identified as promising but not yet proven. A site specific study identified three industrial-sized FGD installations with inherent availabilities in excess of 98%.

CR 80.024
Cargo Fire Hazards and Hazard Control for the Supplement Fuel Supply Assembly (SFSA), Norman, Okla., Energy Analysts, Inc., Aug 1980, N68305-79-C-0021, ADA089335

This study evaluates potential fuel spills, spill fires, and fuel spill hazards at a supplemental fuel supply installation. Potential fuel spill sources, probabilities, and volumes are calculated. Consequences of these spills assuming spill ignition are quantified. Logistic support, manpower, and training needed to maintain the recommended spill control systems are detailed.

CR 80.025
Testing and Evaluation of Attack Resistance and Hardening Retrofits of Marine Barrack Construction Types to Small Arms Multiple Impact Threat, J. B. Patton, A. B. Wenzel, San Antonio, Tex., Southwest Research Institute, Aug 1980, F41608-79-D A011-0008, ADB051196L

The increased potential of coordinated attacks on various sensitive military areas has generated the requirement to provide an increased measure of protection for selected targets. The threat in this case has been defined as 25 rounds of 7.62 NATO ball ammunition fired from an M-60 machine gun at a range of 25 yards. This attack threat is termed Small Arms Multiple Impact Threat or SAMIT. In order to test the SAMIT against various types of standard construction materials, specimens were constructed of 6-, 8-, and 10-inch reinforced concrete, 8- and 12-inch grout filled concrete blocks and hollow concrete blocks protected by a specially designed steel and plywood layered barrier.

Performance is calculated on a monthly basis. The reports are presented for five (5) geographical regions with content and text format similar, differing only in the appropriate regional factors. This volume gives appropriate designs for Navy installations in East Coast regions with temperate climate.

CR 82.004
Design Calculation Procedure for Passive Solar Houses at Navy Installations in Regions with Warm, Humid Climate, Vol III, M. Lumsdaine, E. Lumsdaine, Las Cruces, NM, New Mexico State University, Oct 1981, N62583-79-MR-585, ADA108384

These reports present design calculation procedures for passive solar houses. A "worksheet" approach is used in that the user may work through an example passive solar design by following the text in the report. Included are tables for heating degree days, solar heat gains, building R factors, orientation factors, roof overhang designs, etc. Performance is calculated on a monthly basis. The reports are presented for five (5) geographical regions with content and text format similar, differing only in the appropriate regional factors. This volume gives appropriate designs for Navy installations in regions with warm, humid climate.

CR 82.005
Design Calculation Procedure for Passive Solar Houses at Navy Installations in the Pacific Northwest, Vol IV, M. Lumsdaine, E. Lumsdaine, Las Cruces, NM, New Mexico State University, Oct 1981, N62583-79-MR-585, ADA108385

These reports present design calculation procedures for passive solar houses. A "worksheet" approach is used in that the user may work through an example passive solar design by following the text in the report. Included are tables for heating degree days, solar heat gains, building R factors, orientation factors, roof overhang designs, etc. Performance is calculated on a monthly basis. The reports are presented for five (5) geographical regions with content and text format similar, differing only in the appropriate regional factors. This volume gives appropriate designs for Navy installations in the Pacific Northwest.

CR 82.006
Design Calculation Procedures for Passive Solar Houses at Navy Installations in Warm California Climates, Vol V, M. Lumsdaine, E. Lumsdaine, Las Cruces, NM, New Mexico State University, Oct 1981, N62583-79-MR-585, ADA108386

These reports present design calculation procedures for passive solar houses. A "worksheet" approach is used in that the user may work through an example passive solar design by following the text in the report. Included are tables for heating degree days, solar heat gains, building R factors, orientation factors, roof overhang designs, etc. Performance is calculated on a monthly basis. The reports are presented for five (5) geographical regions with content and text format similar, differing only in the appropriate regional factors. This volume gives appropriate designs for Navy installations in warm California climates.

CR 82.007
A Passive Solar Retrofit Study for Concrete Block Buildings, W. O. Wray, C. R. Miles, C. E. Kosiewicz, Albuquerque, N.M., Department of Energy, Albuquerque Operations Office, Los Alamos National Laboratory, Jan 1982, N68305-81-MP-10003, ADA110189

A passive solar retrofit study has been conducted for the Navy at the Los Alamos National Laboratory. The purpose of the study was to determine the energy savings obtainable in concrete block buildings from several passive solar heating and conservation strategies. A procedure involving the use of test cell data and computer simulation was employed to assess the merits of six retrofit options. The six strategies selected were chosen on the basis of providing a series of options that will deliver increasing energy savings at the cost of correspondingly increased levels of commitment.

CR 82.008
Morison's Equation and the Wave Forces on Offshore Structures, T. Sarpkaya, Carmel, CA, Dr. Turgut Sarpkaya, Dec 1981, N68305-80-C-0053, ADA137438

The origin and limitations of the Morison-O'Brien-Johnson-Schaff (MOJS) equation, the nature and decomposition of the time-dependent in-line force, the speculative generalizations of the MOJS equation to body shapes other than circular cylinders, to yawed cylinders, to wave-current combination, and to dynamice response of structures are discussed in detail. The background and the limitations of the existing data are reviewed and the data from sinusoidally-oscillating planar flow about smooth and rough circular cylinders are chosen to critically assess the MOJS equation. Six methods are examined to delineate the limitations of the MOJS equation and to devise a new force expression. The final method used (the Fourier analysis of the residues) led to the formulation of a three-term and a Four-term MOJS equation. It is shown through numerous examples that the new MOJS equation reduces the residue significantly for both smooth and rough circular cylinders, particularly in the drag-interia dominated regime. Finally, the applicability of the new equation to the ocean conditions and the effect of spanwise coherence are discussed and numerous research projects are recommended for consideration. The suggesting is made that further improvement and understanding of the MOJS equation rest not only with carefully conducted laboratory investigations but also with additional ocean tests designed to shed light on several complicating influences such as the spanwise coherence of vortices and vortex interactions.

CR 82.009 - Cancelled

CR 82.010
A Review of Added Mass and Fluid Inertial Forces, C. E. Brennen, Sierra Madre, Calif., C. E. Brennen, Jan 1982, N62583-81-MR-554, ADA110190

This report reviews the existing state of knowledge concerning the evaluation of the forces imposed on a body in a fluid due to acceleration of either the body or the fluid. It concentrates on those fluid inertial forces due to acceleration rather than on the drag/lift forces due to steady motion. The first part of the report presents a survey of the analytical background including the definition of added mass, the structure of the added mass matrix and other effects such as the influence of viscosity, fluid compressibility and the proximity of solid and free surface boundaries. Then the existing data base from experiments and potential flow calculations is reviewed. Approximate empirical methods for bodies of complex geometry are explored in a preliminary way. The possible dramatic effects of the proximity of the ocean bottom are further highlighted. The confus state of affairs regarding the possibly major effects of viscosity in certain regimes of frequency and Reynolds number is discussed. Finally a number of recommendations stemming from ocean engineering problems are put forward.

CR 82.011
Economic Analysis of Airfield Pavement Rehabilitation Alternatives - An Engineering Manual, J. A. Epps, C. V. Wootan, Bryan, Tex., J. A. Epps, Consulting Engineer, Mar 1982, N62583-81-MR-328, ADA112550

The manual describes a method for evaluation of pavement rehabilitation alternatives based on a present worth or present value economic model. Methods for selecting pavement rehabilitation, recycling and maintenance alternatives are presented together with a method for determining thickness requirements for overlay on airfield pavement facilities.

Guidelines are presented to allow the engineer to select an appropriate discount rate, analysis period and salvage values for use in the life cycle cost calculations. Prices

and costs of pavement rehabilitation and recycling maintenance techniques are given and are suggested for use if costs of these operations are not available from historical records. Cost updating procedures are also defined.

Two example problems are included in the manual to illustrate the techniques of present worth life cycle costing. (Also published as DOT/FAA/RD-81/78.)

CR 82.012

A Newton-Lanczos Method for Solution of Nonlinear Finite Element Equations, B. Nour-Omid, Berkeley, Calif., Department of Civil Engineering, University of California, Feb 1982, N62583-82-MR-419, ADA112043

The finite element method reduces nonlinear continuum problems to nonlinear discrete problems which take the form of systems of nonlinear algebraic equations. Attention is devoted to procedures which may be employed to solve the resulting nonlinear algebraic systems. The general class of continuum problems of interest include both material and geometric nonlinearities.

Newton's method, modified Newton methods, and quasi-Newton methods are reviewed. However, the technique which has been given focus is the Newton-Lanczos method which is a member of the class of solution methods that employ an iterative, linear equation solver in an inner loop within Newton's method.

The Newton-Lanczos algorithm is shown to not only require fewer factorization steps than either the quasi-Newton or modified Newton methods but also possesses more robust convergence characteristics when dealing with nearly singular Jacobian matrices and indefinite systems.

CR 82.013

A Verification Study for the Bounding Surface Plasticity Model for Cohesive Soils, L. R. Herrmann et al., Davis, Calif., Department of Civil Engineering, University of California, Mar 1982, N62583-81-MR-320, ADA113673

Results of drained and undrained, triaxial compression and extension, and thick-walled cylinder laboratory tests are given for a laboratory prepared kaolin soil. For the soil in question, a portion of the data is used to calibrate a "bounding surface plasticity model" for cohesive soils. The model is used to analyze the remaining tests and the results are compared to the measured values with good agreement.

CR 82.014

Test Cases for SEADYN Verification, P. E. Nordstrom, H. Ottsen, Oxnard, Calif., Western Instruments Corp., Apr 1982, N68305-80-C-0004, ADA114978

This report includes actual input decks and associated outputs for demonstration of the SEADYN cable dynamics computer model. The input problems are intended to allow for the verification of the model if it is transferred for operation on non-CDC® computers.

CR 82.015

Validation of Computer Models of Cable System Dynamics, D. B. Dillon, Rockville, Md., EG&G Washington Analytical Services Ctr., Apr 1982, N68305-80-C-0020, ADA114957

Comparisons are made between measurements taken during four series of dynamic cable experiments and simulations of the experimental events using two computer models, SEADYN and SNAPLOAD, under the sponsorship of the Naval Civil Engineering Laboratory. Three of the experiments were conducted in laboratory water tanks using an elastically stiff nylon cord and a soft silicon rubber cable.

The first experiment used cables 6 feet long. Five distinct geometries were measured, including simulation of the anchor-last deployment of a single mooring leg, the relaxation of a subsurface mooring from a displaced condition, and the response of a load suspended along a cable fixed at one end and moved around a circle at the other. The deployment and relaxation simulations were repeated in the second experimental series, using cables 60 feet long. The tension was measured during the third series while a weight suspended from the nylon or rubber cable was payedd out or reeled in from a small winch. The winch base could be oscillated vertically to simulate wave action.

The fourth experiment was the deployment of a full-size instrumented subsurface mooring in 2,500 feet of water off Kauai, Hawaii as part of the joint Mooring Dynamics Experiment (MDE) conducted in late 1976.

SEADYN is a general three-dimensional model of the dynamic response of cable networks to environmental changes using a nonlinear finite element technique in the time domain. SNAPLOAD uses the lumped parameter method to model the dynamics of serially connected cables suspended in a vertical plane. Both models are shown to reproduce all the significant motions and forces in the modeled events, but tensions are introduced in both models by the inaccurate hydrodynamic drag coefficients that they use.

Material damping caused by elastic hysteresis in the cable material is found to play a significant part in smoothing the computation of cable tension, even though it has little overt relation to the overall event. Small amounts of material damping are sufficient to prevent undesirable oscillations between model nodes; larger values enable SEADYN to accurately model the forced oscillation of the anchor as the length of the suspension cable was varied through resonance.

The laboratory experiments were restricted to serially connected cables and special buoys or anchors suspended in a vertical plane in still water in order to make the data useful for comparing simple computer models as well as stances by comparing equilibrium and steady-state conditions to results obtained from elementary theory. The data from all four experiments are available for evaluating other models.

CR 82.016

SEAPLOT: A Graphics Post-Processor for the SEADYN Program, R. L. Webster, Brigham City, Utah, Dr. R. L. Webster, Consulting Engineer, Apr 1982, N62474-81-C-9391, ADA114961

This report describes the computer program named SEAPLT, which is a graphics post-processor to the general purpose cable dynamics computer model named SEADYN. The program is written with CALCOMP® compatibility for use with the CDC-Cybernet® program UNIPLOT.

CR 82.017

A Compendium of Tension Member Properties for Input to Cable Structure Analysis Programs, J. F. Wadsworth, Oxnard, Calif., Western Instruments Corp., Apr 1982, N68305-80-C-0004, ADA115019

This report is a collection and condensation of cable properties used in computer simulations of cable dynamics problems. Data were taken from a variety of sources, and include weight per foot (in air and immersed), elastic modulus, breaking strength, cross-sectional area, and drag and added mass coefficients. Cable types include chain, wire rope, synthetic and electromechanical.

CR 82.018

SEADYN: Programmer's Reference Manual, R. L. Webster, Brigham City, Utah, Dr. R. L. Webster, Consulting Engineer, Apr 1982, N62474-81-C-9391, ADA115011

The internal workings of the SEADYN cable, truss, and mooring program are detailed. Descriptions are given of the overall program structure and logic. Storage features, such as COMMON, data files, and variable dimensions are discussed. Descriptions are given for each of the subroutines and the major variables used. The information provided is intended to augment the general description of the program provided in the User's Manual and Mathematical

Models and provide a programmer with assistance in understanding the internal workings of the SEADYN programming. Instructions for converting the program to various machines and for modifying the program are also provided.

CR 82.019
SEADYN Mathematical Models, R. L. Webster, Brigham City, Utah, Dr. R. L. Webster, Consulting Engineer, Apr 1982, N62474-81-C-9391, ADA114994

This manual presents the theoretical background material for the SEADYN cable, truss, and mooring program. SEADYN uses the finite element method for modeling the cables, trusses, and mooring lines. Two elements are treated: the one-dimensional Simplex (truss) element and a bottom-limited catenary. Lumped parameter concepts are used in treating buoys, anchors, floats, etc. Rigid body models are used for ships, platforms, mooring buoys, etc. A cartesian 3-D geometric space is used throughout. Besides describing the element and body equations for submerged responses with large displacements, this manual discusses the various static and dynamic solution methods employed.

CR 82.020
A Viscoplastic Plane Frame Beam-Column Element for Program FEAP, J. H. Slater, R. L. Taylor, Berkeley, Calif., University of California, May 1982, N62583-81-MR-439, ADA114461

A two-dimensional viscoplastic beam element was developed for the computer program FEAP. The element is suitable for small displacements or moderate rotations with negligible shear. The element is formulated in moment-thrust space which will improve modeling of concrete beams. The viscoplastic formulation provides time dependent effects such as the influence of the strain rate upon the yield strength.

CR 82.021
A Viscoplastic Algorithm for CAP75, M. G. Katona, M. A. Mulert, Notre Dame, Ind., Department of Civil Engineering, University of Notre Dame, May 1982, N68305-80-C-0031, ADA114460

A viscoplastic formulation based on Perzyna's elastic/viscoplastic theory is developed for geological materials using the Sandler and Rubin CAP75 plasticity model. The numerical strategy employs a one parameter Crank-Nicolson time integration scheme which provides options for explicit and implicit algorithms. A computer program called VPDRVR exercises these algorithms for arbitrary states of stress or strain.

CR 82.022
A Systematic Procedure for Calculating the Average Illuminance on a Work Plane from Skylights Located in a Pitched Roof, J. B. Murdoch, J. E. Nettleton, Durham, N.H., Department of Electrical Engineering, University of New Hampshire, May 1982, N62583-81-MR-307, ADA115523

A systematic design procedure has been developed to calculate the average horizontal illuminance upon a work plane due to skylights in a pitched roof. The calculation procedure allows for pitched roofs with slopes up to 30 degrees from horizontal, and for both clear and overcast sky conditions. The procedure is divided into two basic steps: (1) the calculation of total external daylight illuminance upon the sloped skylight surface, and (2) the calculation of average horizontal illuminances upon an interior workplane due to the sloped skylights. Worksheets are used to systematically step through the procedure. All necessary tables and equations are included.

CR 82.023 - Cancelled

CR 82.024 - Cancelled

CR 82.025
Development of a Seawater Hydraulic Tool System, R. Graham, G. G. Hastings, Annapolis, Md., Westinghouse Electric Corp., Oceanic Division, May 1982, N00123-80-C-1271, ADA114960

The Naval Civil Engineering Laboratory is developing a diver-operated hydraulic tool system that uses seawater as the working fluid. The program was initiated in 1976 with the subsequent development of an experimental balanced vane by 1980. Late in 1980 a contract was awarded to improve the performance of the experimental vane motor and make it reversible, to couple the motor to a rotary impact mechanism with appropriate control to form a diver-operated impact wrench, and to develop a diesel-operated portable power supply for operating the tool. This report describes the successful development of this experimental seawater hydraulic tool system.

CR 82.026
Appendix to Development of a Seawater Hydraulic Tool System, R. Graham, G. G. Hastings, Annapolis, Md., Westinghouse Electric Corporation, Oceanic Division, May 1982, N00123-80-C-1272, ADB063681L

The Naval Civil Engineering Laboratory is developing a diver-operated tool system that uses seawater as the working fluid. In the fall of 1978, work began on the development of an experimental vane motor capable of powering diver-held tools. Material requirements for the vane motor components were investigated in detail, and an engineering model of the motor was designed and fabricated using the most promising materials. The best results were obtained by using Torlon 4275, a high-strength thermoplastic, for the vanes, side plates, and bearings, and Inconel 625, a high-nickel-based alloy, for the housing and rotor. Based on the results of engineering development, an experimental vane motor was fabricated and tested in the laboratory. The motor, with a volume of about 25 $in.^3$, weighs 5 pounds, and produces 3.3 hp at 1,600 rpm with 80% overall efficiency when supplied with 7 gpm of seawater at 1,000 psi. More than 60 hours of full-power operation have been achieved. The results to date of the development and testing are presented in this report.

CR 82.027
Energy Monitoring and Control Systems Operator Training - Recommended Qualifications, Staffing, Job Description, and Training Requirements for EMCS Operators, C. Cornelius, B. Wise, Atlanta, Ga., Newcomb & Boyd, Consulting Engineers, Jun 1982, N62474-81-C-9405, ADA116835

This report includes a review of: (1) operator training provided by EMCS contractors, (2) the requirements for training by the Tri-Service Specifications, and (3) the present operation of several functioning EMCS installations.

From the information gathered, recommendations were made in regard to qualifications, staffing, job description, and training requirements for a competent EMCS operator.

It is recommended that training be given in four phases: (1) Shop Rotation, (2) EMCS Operator Training Course, (3) Vendor Training, and (4) On-the-Job Training.

Detailed objectives, course outline, and manual outline for the proposed EMCS Operator Training Course are provided in Section 3 of this report.

CR 82.028
Controlling Energy Consumption in Single Buildings, J. Rees, Atlanta, Ga., Newcomb & Boyd, Consulting Engineers, Jul 1982, N62583-81-MR-593, ADA118898

This report contains guidelines for using microprocessor-based equipment to control energy in buildings. Energy conservation control strategies are discussed and simplified energy savings calculations explained. The results of a survey of currently available equipment suitable for use as energy controllers are included as well as selection guidance for which class of equipment will provide the needed features.

CR 82.029
Reliability, Maintainability, Availability; Thermal Efficiency; and Cost Effectiveness Evaluation of Naval Station Mayport Heat Recovery Incinerator, Oxnard, Calif., VSE Corporation, Jul 1982, N00123-82-D-0149, ADA118523

This report addresses the long-term evaluation of the Mayport heat recovery incinerator program. Operational data were collected from 29 Sep 1980 to 28 Sep 1981 and then analyzed for reliability, availability, maintainability, thermal efficiency, and operating cost.

CR 82.030
Standardized EMCS Energy Savings Calculations, C. Cornelius, Atlanta, Ga., Newcomb & Boyd, Consulting Engineers, Sep 1982, N62474-81-C-9382, ADA123383

This report describes standardized methods for determining energy savings obtainable from EMCS applications programs using manual and computerized algorithms. The methods will provide reasonable approximations of savings but not detailed energy analyses of building operations.

CR 32.031
Conceptual Design of Navy Floating Pier, San Francisco, Calif., T. Y. Lin International, Sep 1982, N62474-81-C-9404, ADA121865

An innovative concept for a floating pier to serve Navy surface combatants has been developed. The prestressed concrete pier is 1,200 feet long and 75 feet wide and offers a number of advantages over conventional pile supported piers. These advantages include:

(a) A constant deck elevation with respect to berthed ships which results in decreased need to tend utility and mooring lines.
(b) A full interior deck which doubles the available length of ship-to-pier interface.
(c) A clear top deck with all utility lines located under the deck and accessible from the lower interior deck.
(d) A modern cell-type fender system.

In addition, the floating pier has significant merit when used to replace an existing deteriorated pier. The floating pier can be constructed in modules offsite while the old pier is demolished, the modules then floated into position, and the construction completed at the original pier site. Using the floating pier approach, the Navy would have an operational pier at least 12 months sooner than would be the case with a fixed pier. The initial cost for a floating pier has been estimated to be about 14% higher than that for a comparable pile supported pier.

CR 82.032
Reliability Engineering Analysis - Small-Scale Heat Recovery Incinerator Installations, Oxnard, Calif., VSE Corporation, Sep 1982, N00123-82-C-0149, ADA122408

This report addresses the reliability prediction conducted on the two Navy owned and operated heat recovery incinerator systems. The prediction was based on a part counts method and the original designs of the two HRI systems. Based on this prediction, long term data collected at Mayport and Jacksonville HRI systems and mission requirements, testing procedures for HRI systems have been identified. Included in this report is a failure modes and effects analysis conducted at these HRIs.

CR 82.033
Safety and Human Factors Engineering Analysis - Heat Recovery Incinerator Installation, Oxnard, Calif., VSE Corporation, Sep 1982, N00123-82-C-0149, ADA122538

This report contains a safety and human factors analysis of the Navy's heat recovery incinerator (HRI) systems. These requirements were based on current military standards and an evaluation of the HRI's at NAS, Jacksonville and NS, Mayport, FL. The data collected were used to develop preliminary design criteria for future HRIs.

The safety analysis lists specific areas where problems can occur and what should be done to prevent injury to plant personnel. The human factors design criteria section lists steps that can be taken to improve personnel and plant operating efficiency. Finally, specific problems that are occurring at NAS, Jacksonville and NS, Mayport are given.

CR 82.034
Energy Storage Criteria Handbook, J. R. Hull, R L. Cole, A. B. Hull, Argonne, Ill., Argonne National Laboratory, Oct 1982, N68305-81-MP-10027, ADA125180

The purpose of this handbook is to provide information and criteria necessary for the selection and sizing of energy storage technologies for use at U.S. Naval facilities. The handbook gives Naval base personnel procedures and information to select the most viable energy storage options to provide the space conditioning (heating and cooling) and domestic hot water needs of their facility. The handbook may also be used by contractors, installers, designers, engineers, architects, and manufacturers who intend to enter the energy storage business.

The handbook is organized into three major sections: a general section, a technical section, and an example section. While a technical background is assumed for the latter two sections, the general section is simply written and can serve as an introduction to the field of energy storage. The technical section examines the following energy storage technologies: sensible heat storage, latent heat storage, cold storage, thermochemical storage, mechanical storage, pumped hydro storage, and electrochemical storage. The example section is limited to thermal storage and includes examples for: water tank storage, rockbed storage, latent heat storage, and cold water storage.

CR 83.001
Energy Monitoring and Control Systems Inspection Guidelines, J. Cosiol, F. Bomar, R. Bamford, Philadelphia, Pa., Kling-Lindquist, Inc., Engineers, Dec 1982, N62474-81-C-9379, ADA129732

This report presents guidelines which can assist the inspector in conducting an inspection of energy monitoring and control system (EMCS) hardware and software during the construction and testing phases of the EMCS project. These guidelines present construction management considerations, describe the inspection sequence for a generic EMCS during the construction period, and provide an overview of the tests to be conducted in the factory and on-site.

CR 83.002
Energy Monitoring and Control Systems - Factory Test Procedures, J. Cosiol, F. Bomar, Philadelphia, Pa., Kling-Lindquist, Inc., Engineers, Dec 1982, N62474-81-C-9379, ADA124047

This report presents generic factory test procedures for EMCS. These test procedures are designed to demonstrate in the factory the technical, operational, and performance of an EMCS procured using the tri-service EMCS guide specifications.

CR 83.003
Energy Monitoring and Control Systems - Performance Verification and Endurance Test Procedures, J. Cosiol, F. Bomar, Philadelphia, Pa., Kling-Lindquist, Inc., Engineers, Dec 1982, N62474-81-C-9379, ADA123821

This report presents generic tests designed to assist in assuring that EMCS installed using the tri-service EMCS guide specifications meet the specified technical, operational, and performance requirements.

CR 83.004
Vortex Shedding from Cables and Structures in a Shear Flow: State-of-the-Art, O. M. Griffin, Washington, D.C., Marine Technology Division, Naval Research Laboratory, Nov 1982, N68305-82-WR-20092, ADA121864

This report examines the general problem of the flow about bluff bodies in a shear flow in light of the present state of knowledge for these flows, and relates existing studies to the vortex-excited oscillations of slender, flexible structures in air and in water. Experiments with circular cylinders are emphasized, although reference also is made to experiments conducted with cylinders of other cross-sections (D-section cylinders, rectangular cylinders, etc.). Some recent experiments with flexible cables in a shear flow are discussed to the extent possible.

Many of the studies conducted thus far have been limited to cylinders with small aspect ratios or length/diameter less than L/D = 15 to 20. The cellular structure of the vortex shedding is influenced strongly by the end conditions for cylinders with these relatively small values of L/D and so it is important to conduct experiments with cylinders of sufficient length to minimize the effects of the end boundaries. The results obtained from experiments such as these are of particular importance in the design of long, flexible marine structures and cable arrays.

The effects of incident shear on the cross flow response of lightly damped structures in air and in water should be investigated further. The experiments conducted thus far have demonstrated that cylindrical structures undergo large-amplitude unsteady motions in shear flows when the critical incident flow velocity is exceeded and the damping is sufficiently small. However, more definitive bounds for and details of this fluid-structure interaction are required for applications in both wind engineering design of buildings and structures and ocean engineering design of structures and cable systems.

CR 83.005
Handbook of Thermal Insulation Applications, D. E. Croy, D. A. Dougherty, Denver, Colo., EMC Engineers, Inc., Jan 1983, N62474-81-C-9395, ADA125264

This document is intended to provide current design information on insulation materials and assemblies for building envelopes and mechanical systems.

Compiled data include thermophysical properties of commonly used generic thermal insulating materials and their application in wall, floor and roof assemblies, door and window assemblies, and in mechanical piping, tanks, vessels, equipment, and air duct installations.

Listings of insulation materials are sorted by both manufacturer's trade names and by product descriptions. Plates showing typical new and retrofit installation details for these materials in building assemblies and mechanical systems are provided.

An understanding of how insulation conserves energy and fundamentals of heat transfer are provided. Information on computer programs for heat transmission, mass and thermal capacity calculations is included. Examples are given that show how the document can be used to estimate energy savings attainable with thermal insulation in building wall and piping assemblies. Methods for optimizing insulation thicknesses are provided in a section on insulation economics.

CR 83.006
Problem Definition Study of Requirements for Vapor Retarders in the Building Envelope, P. R. Achenbach, H. R. Trechsel, Germantown, Md., H. R. Trechsel Associates, Nov 1982, N62583-81-MR-671, ADA122203

This document provides a state-of-the-art review and evaluation of current design criteria for vapor retarders. It also suggests general criteria for vapor and air leakage control in Navy building envelopes and recommends specific RDT&E to resolve conflicting criteria, develop remedial measures for existing buildings and prepare guidelines for new construction to prevent the types of moisture and fungus problems currently being experienced, particularly in tropical and subtropical environments.

CR 83.007
Innovative Design Concepts - Piers for Surface Combatants (Destroyers, Frigates and Light Cruisers), Sidney M. Johnson and Assoc., Union, N.J., Sidney M. Johnson and Assoc., Jan 1983, N62474-81-C-9396, ADB070971L

Navy piers constructed to support the Fleet since World War II no longer are capable of responding adequately to today's modern Naval ships with their sophisticated systems and increased demands for service.

Deficiencies in current pier designs were identified and the following has been concluded about the design of future piers: (a) Piers should be operationally adaptive and designed to provide an excess (over immediate requirements) of space, deck load capacity, and utility service. (b) Contact footage between pier and ship is more important than total deck area. This could be achieved with a multiple deck pier or with a pier that features access to both sides of a berthed ship. (c) Pier deck elevation could be raised 4 to 5 feet without any attendant loss of service function. A raised deck would allow a full depth utility gallery beneath the deck. (d) Maintenance and damage prone timber fender systems should be replaced by more modern systems constructed of concrete, steel, and elastomer components.

A number of concepts for pile supported and filled type construction piers are presented which illustrate application of the investigation conclusions.

CR 83.008
EMCS Cost Estimating Data, C. Cornelius, Atlanta, Ga., Newcomb & Boyd, Consulting Engineers, Jan 1983, N62474-81-C-9382, ADA123673

This report provides current cost estimating data for large, medium, and small EMCS. The report includes unloaded material and labor costs obtained from equipment manufacturers of system components. It also suggests factors to be used in determining total costs and provides samples of point cost deviations.

CR 83.009
CEL-1 Lighting Computer Program - Programmer's Guide, W. E. Brackett, New York, N.Y., The F + K Group, Jan 1983, N68305-80-C-0012, ADA124215

The basic algorithms and program file structure of the CEL-1 (Conservation of Electric Lighting, Version 1.0) lighting computer program are documented. The CEL-1 computer program aids the illumination engineer in designing energy efficient interior lighting systems. Lighting metrics which may be calculated include illuminance luminance, equivalent sphere illumination, and visual comfort probability. Energy profiles resulting from lighting controls which respond to daylight can be evaluated using CEL-1. This programmer's guide is divided into seven sections: (1) Programs Structure, (2) Basic Techniques, (3) Main Program Descriptions, (4) Subprogram Descriptions, (5) Logical Unit Assignments, (6) Compiling the Programs, and (7) Source and Auxiliary Files.

CR 83.010
Numerical Implementation of the Cohesive Soil Bounding Surface Plasticity Model, Vol. I, L. R. Herrmann et al., Davis, Calif., University of California, Feb 1983, N62474-82-C-8276, ADA124866

The results of a study of various numerical means for implementing the bounding surface plasticity model for cohesive soils are presented. A comparison is made of the

computational efficiency, robustness, and ease of implementation of the completing methods. The comparisons are made on the basis of solutions to three representative geotechnical engineering problems.

A very brief description of a computer aided automated calibration procedure is given along with instructions for using the resulting computer code. An example calibration is reported for a particular cohesive soil.

CR 83.011
User's Manual for MODCAL - Bounding Surface Soil Plasticity Model Calibration and Prediction Code, Vol. II, J. S. DeNatale, L. R. Herrmann, Y. F. Dafalias, Davis, Calif., Department of Civil Engineering, University of California, Feb 1983, N62474-82-C-8276, ADA124867

In recent years, much research has been directed towards the development of sophisticated constitutive models which can more realistically account for the diverse stress-strain phenomena exhibited by soils and other earth materials. Most of these models employ parameters whose optimal values can only be established through a trial-and-error curve fitting process, with the objective being to obtain the best overall fit to a given experimental relation or set of observed responses. As a result, the accuracy and efficiency of this model calibration process can be highly dependent on both the subjectivity of the user as well as his familiarity and expertise with the particular constitutive formulation. In order to minimize this user dependence, and thereby significantly reduce the complexity of the model calibration process, a computer aided automated procedure has been developed and tested. The computer code employs a Quasi-Newton optimization strategy to locate that set of parameter values which minimizes the discrepancy between the model predictions and the experimental observations included in the calibration data base. Through application to a number of real soils, the automated procedure has been found to be an efficient, reliable and economic means of accomplishing model calibration. Although the code was developed specifically for use with the Bounding Surface plasticity model, it can readily be adapted to other constitutive formulations. Since the code greatly reduces the dependence of calibration success on user expertise, it significantly increases the accessibility and usefulness of sophisticated material models to the general engineering community.

CR 83.012
Boiler Control Survey Report, Irvine, Calif., Ultrasystems, Inc., Feb 1983, N62474-81-C-9388, ADA124994

Report presents results of survey of types of boiler control systems in use in Naval shore facilities.

CR 83.013
Boiler Control Systems Theory of Operation Manual, Irvine, Calif., Ultrasystems, Inc., Feb 1983, N62474-81-C-9388, ADA124868

Report reviews the fundamentals of combustion, safety, and feedwater control systems commonly used on small industrial boilers. Report is educational material for boiler operation and maintenance personnel.

CR 83.014
Boiler Control Systems Oxygen Trim Systems Manual, Irvine, Calif., Ultrasystems, Inc., Feb 1983, N62474-81-C-9388, ADA125159

Report is educational material for boiler operating personnel describing the principles which govern excess-air trim systems and their application to industrial boiler combustion control for the purpose of increasing the boiler's efficiency.

CR 83.015
Direct Digital Boiler Control Systems for the Navy Small Boiler Requirement, Irvine, Calif., Ultrasystems, Inc., Feb 1983, N62474-81-C-9388, ADA125160

Fifteen manufacturers of direct digital boiler control systems were surveyed. The results are presented in a comparison chart supplemented by narrative discussion. Recommendations for incremental application of these systems to the Navy's small boiler control requirement are presented, as well as estimated cost projections for single and multiple boiler control application.

CR 83.016
Preliminary Operating Assessment Advanced Heat Recovery Incinerator Site Two: Basic Environmental Engr., Inc., R. L. Streeter, G. J. Matzuk, Pottstown, Pa., Sanders & Thomas, Inc., Consulting Engineers, Mar 1983, N68305-80-C-0060, ADA125157

This brief evaluation of a Basic Environmental Engineering, Inc. heat recovery incinerator (HRI) documents and describes several innovative features not found in most other modular HRIs this small. These features and subsystems include: waterwall primary combustion chamber, pulsed hearths for burning material transport, multiple zone control of secondary combustion, ash removal subsystem with no moving linkages under water, and partial integrated digital controls. The system start-up experience, also well documented, may be considered typical or better than average for many modular HRIs in the last few years.

For further information, contact P. L. Stone, A/V 360-5925 or FTS 799-5925/5974 or commercial (805) 982-5925/5974.

CR 83.017
Survey of Small Scale Heat Recovery Incinerators, J. K. Tuck, D. J. Lafrenz, Richmond, Calif., Cal Recovery Systems, Inc., Feb 1983, N62583-82-MR-460, ADA125543

Solid waste heat incinerator (HRI) facilities within the United States, which were capable of 24-hr/day operation, had operated for about a year, and had combustors of between 0.75-3.00 ton/hr capacity, were identified to permit selection of best facilities for field visits. Thirteen manufacturers of HRI were identified.

CR 83.018
Air Leakage Measurements in Navy Family Housing Units at Norfolk, Virginia, P. L. Lagus, La Jolla, Calif., S-CUBED, Apr 1983, N68305-79-C-00344, ADA128562

A series of tests was conducted in 24 Navy family housing units to determine the effectiveness of three retrofit techniques in reducing air leakage. Effectiveness was determined by fan pressurization/depressurization tests before and after the retrofits were installed. In two other housing units, other types of retrofits were simulated by using tape and plastic sheeting at suspected leakage points.

This report covers the measurement techniques used, air leakage data collected, and conclusions and recommendations based on the tests.

CR 83.019
Acoustical Benefits Resulting From Insulation and Air Leakage Control in Family Housing Units, J. D. Verschoor, J. D. Haines, Denver, Colo., Manville Service Corp., R&D Center, Jul 1983, N62583-82-MT-033, ADA131879

In an investigation sponsored by the Navy Family Housing Office, a series of tests was conducted to determine the improvement in acoustical sound transmission loss resulting from housing envelope energy conservation retrofits involving increasing the insulation level and/or controlling the air leakage. The data generated will be utilized in selecting energy conservation measures with maximum acoustical benefits, for retrofitting family housing units near aircraft operations, where excessive noise has been a problem.

Three wall and two roof/ceiling test structures were constructed to be representative of those in present Navy Family Housing Units. The sound transmission loss and air leakage rate (resulting from an induced pressure differential) were determined for each basic construction. Subsequently, various retrofit measures were performed, designed to improve sound transmission loss, thermal performance and/or air leakage control. Following the retrofit, the improvement in air leakage rate and sound transmission loss were again determined. The thermal conductances of the base constructions and that of the retrofits were calculated. For those constructions where present data were felt to be inadequate, guarded hot box tests were conducted to determine the thermal conductance of the construction.

Data are presented on the sound transmission loss, overall sound transmission class (STC), air leakage rate, and thermal conductance of the constructions tested. Typical (1982) retrofit costs are also estimated, so that benefit-to-cost performance can be analyzed.

CR 83.020
An Investigation of the Effects of Grain Crushing on the Engineering Analysis of Calcareous Sediments, Long Beach, Calif., Ertec Western, Inc., Mar 1983, N62474-82-C-8269, ADA126860

Sixteen specially prepared laboratory soil specimens were subjected to model pile driving to induce grain crushing about the pile perimeter and study the effects grain crushing has on the engineering analysis of calcareous sediments. Each specimen constituted a particular material, level of degree of cementation, and density. The parameters measured for each test were the pile driving resistance, pile pullout resistance, and grain size analysis curves determined before and after pile driving for areas next to and remote to the pile surface. The results of this experiment revealed that crushability depends on the interrelated effects of grain harness, pile penetration resistance to driving, cement content, and soil density. A significant finding showed that the pile driving resistance is not a rational parameter in assessing pullout capacity for piles in calcareous sands.

CR 83.021
EMCS Operator Training Manual, C. Cornelius, B. Wise, S. Bruning, Altanta, Ga., Newcomb & Boyd, Consulting Engineers, Apr 1983, N62474-81-C-9405, ADA128087

This manual is a training aide to accompany the EMCS Operator Training Course. It is also intended as a working reference for the EMCS operator. The manual discusses the basics of HVAC system operation covering most systems which would be connected to an EMCS. It includes a generic description of the EMCS hardware, explanations of the energy savings strategies of the EMCS applications software and discussions of EMCS alarm analysis and system operation.

CR 83.022
Boiler Combustion Control Maintenance Manual, Irvine, Calif., Ultrasystems, Inc., Mar 1983, N62474-81-C-9388, ADA127249

Report provides guidance to boiler operating personnel on adjusting and maintaining combustion controls of small industrial boilers.

CR 83.023
Tension Cutoff and Parameter Identification for the Viscoplastic CAP Model, M. G. Katona, Notre Dame, Ind., Department of Civil Engineering, University of Notre Dame, Apr 1983, N62474-82-C-8270, ADA128304

A viscoplastic formulation based on Perzyna's elastic/viscoplastic theory and the Sandler and Rubin CAP75 plasticity mdel was extended to include a tension cutoff mechanism. The mechanism employs separate fluidity parameters for the dilatational and deviatoric stress releases. A parameter identification study was performed to determine the sensitivity of the parameters and means of determining them from experimental data.

CR 83.024
Concepts for Combat Support, Combat Service Support, and POL Requirements and Distribution Concepts to a Mechanized Combined Arms Task Force in the Mid- and Long-Range Time Frames, McLean, Va., Potomac General Research Group, Apr 1983, N62474-81-C-9397, ADA128407

This report presents the results of an investigation of the expected operations and employment of a Marine Corps Mechanized Combined Arms Task Force (MCATF), both in the mid-range (1983-1992) and in the long-range (1993-2000), and formulates concepts for the conduct of combat support (CS) and combat service support (CSS) compatible with MCATF characteristics. The MCATF was selected for investigation because it was expected to severely exercise CS and CSS elements.

The conclusions and recommendations of the report indicate that there is a feasible set of tactical, CS, and CSS concepts suitable for operation of MCATFs on varied depth of penetration missions in the long-range time frame. The CS and CSS concepts described require doctrinal, organizational, and equipment changes and improvements that are justified by the tactical flexibility and capability that they allow MCATFs to display in executing their missions.

Part III of the main body of the report presents an overview of the POL (Class III and IIIA) requirements and distribution concepts, the details of which are contained in Annex B of the report. The most significant aspect of this analysis is the validity of using SIXCON fuel modules as a primary container system for helicopter lift of fuel and subsequent distribution within the MCATF. Also of interest is the finding that AAFS, TAFS, and HERS type systems remain essential to overall capabilities.

CR 83.025
Survey of Foreign Systems for Incineration and Energy Recovery, R. Frounfelker, B. A. Hausfeld, Xenia, Ohio, Systech Corporation, Apr 1983, N62583-82-MT-150, ADA127461

Solid waste heat recovery incinerator (HRI) facilities outside the United States, which were capable of 24-hour a day operation, had operated for about a year, and had combustors of between 0.75 and 3.0 ton/hr capacity, were identified to permit selection of best facilities for field visits. Of the 40 vendors identified, 21 responses were received. Eleven of the vendors had facilities that fit the above criteria. Facilities of six vendors were selected for field visits.

CR 83.026 - Cancelled

CR 83.027
Solution Techniques in Finite Element Analysis, B. Nour-Omid, C. Rodrigues, R. L. Taylor, Berkeley, Calif., University of California, Department of Civil Engineering, May 1983, N62474-82-C-8277, ADA128617

A desirable advantage of iterative methods is that they provide means of controlling the accuracy of the solution. In particular, when low levels of accuracy are required this can result in faster algorithms than the direct methods. The use of the conjugate gradient algorithm to solve the linearized system of equations is considered. A preconditioning matrix based on a splitting method is constructed. The outcome is an algorithm which results in substantial reduction in storage over direct methods. The above method is compared with its rivals on several quite different problems in structural mechanics and favorable results were obtained.

CR 83.028
Preliminary Operating Assessment Advanced Heat Recovery Incinerator (HRI) Site One: O'Connor Combustor Corporation, H. 1. Hollander, G. J. Matzuk, G. Romine, Pottstown, Pa., Sanders & Thomas, Inc., Consulting Engineers, Jul 1983, N68305-80-C-0060, ADA131254

This brief evaluation of the first O'Connor (rotary waterwell) Combustor plant built in the U.S.A. describes design features and considerations as well as initial operating advantages and difficulties. A brief general description of a co-located, proprietary fuel preparation system is included. The major conclusion presented alludes to a waste fuel availability requirement approaching 60 tons per day (tpd) for probable cost effectiveness of this technology.

For further information, contact P. L. Stone, A/V 360-5925 or FTS 799-5925 or commercial (805) 982-5925/5974.

CR 83.029
The Concept and Economics of RDF-3 Utilization in a Navy Size Pulverized Coal Boiler, Bedford, Mass., Waste Energy Technology Corporation, May 1983, N62583-82-MT-189, ADA128588

This report addresses the economics of co-firing refuse derived fuel (RDF) in a pulverized coal boiler. The report specifies the type of RDF required, the type and cost of processing equipment to produce the RDF, the cost and type of modifications to the coal boiler, and the expected O&M costs for the modified boiler. Life cycle economic analyses based on various RDF feed rates are used to determine the suitability of RDF use in a pulverized coal boiler.

CR 83.030
Navy Floating Pier: Investigation of Dynamic Motions, Ramp Supports and Flexible Utility Connections, San Francisco, Calif., T.Y. Lin, International, Jun 1983, N62474-81-C-9404, ADB074755L

The feasibility of a floating pier concept for Navy surface combatants has been investigated further by studying the dynamic motions of the pier and by producing preliminary designs of the ramp supports and flexible utility connections. The dynamic motions of the pier were analyzed for the loading cases of berthing impact of ships, waves generated by passing ships, waves created by storm conditions, long period seiche waves and ground motions from seismic events. For all realistic loading cases, the motions of the pier were reasonable and would not present problems to personnel or equipment operating on the pier. Practical designs have been produced for the ramp supports and flexible utility connections.

CR 83.031
Properties of Weathered Uncoated and "Resaturant"-Coated Bituminous Built-Up Roofing Membranes, R. G. Mathey, W. J. Rossiter, Washington, D.C., National Bureau of Standards, Jun 1983, N68305-82-WR-20172, ADA130563

A study to compare the performance properties of weathered built-up membranes which had and had not been subjected to an application of "resaturant"-type coatings has been conducted. The membrane samples (asphaltic and coal-tar pitch), which were taken from roofs of buildings, ranged in age from 14 to 26 years. Sections of these roofs had been treated with one of three proprietary "resaturant"-type coatings. The age of coatings ranged from 12 to 29 months. The membrane samples removed from the roofs were visually examined in the laboratory to determine their general condition, the extent of adhesion between plies of felts, the number of plies, and the thicknesses of the interply bitumen. The visual examination indicated that damage to some areas of the top ply of felt of most of the coated coal-tar pitch membrane samples had occurred. The damage was attributed, in part, to removal of the aggregate surfacing prior to "resaturant"-coating application. Membrane properties measured in the laboratory for undamaged test specimens were tensile strength, load-strain modulus, flexural strength, maximum deflection (flexure), coefficient of linear thermal expansion, and thermal shock factor. The results are applicable only to the membranes tested since the number of membrane samples and coatings included in the study were limited. Comparisons of the average values of the properties for uncoated and comparable coated specimens in general showed no significant statistical differences. In addition, no consistent trends were found as to whether or not the average values of the measured properties of the coated specimens were higher or lower than those of comparable uncoated specimens.

CR 83.032
Conceptual Designs for Berthing Pier Galleries and Deck Lighting, Houston, Tex., Brown & Root Development, Inc., Jun 1983, N62474-82-C-8303, ADA131463

Preliminary designs are presented for utility galleries to be located below the top deck of new Navy surface combatant piers. The recommended concepts for both pile supported and floating piers are similar. Both concepts have openings for ship-to-shore utility line egress which are essentially continuous along the entire length of the structure. This continuous access is a distinct advantage since it allows utility stations to be developed for new ship classes in the future without regard to pier opening constraints.

The recommended concepts utilize air-powered, fixed reels on the lower deck to both store and/or payout the electrical cables. This unique feature requires positioning of ship alongside the pier to match the electrical station, which can be easily accomplished by properly locating the mooring fittings along the pier.

An evaluation of numerous types of pier deck lighting systems was made, and it was concluded that light standards of moderate height supporting multiple-fixture arrays could be located on a pier with minimal interference with other activities. The recommended system achieves a minimum lighting level of 0.5 footcandles and can concentrate as much as 5.0 footcandles on high-tempo areas.

CR 83.033
RDF Utilization in a Navy Oil-Fired Boiler, G. H. Gardiner, A. K. Chatterjee, Oxnard, Calif., VSE Corporation, Jun 1983, N00123-82-0149, ADA130444

This report addresses the economics of co-firing refuse derived fuel (RDF) in a fuel oil fired boiler. The report specifies the type of RDF required, the cost and type of modifications to the oil boiler, and the price which can be paid for RDF based on boiler size and RDF feedrate. Life cycle economic procedures are used to develop breakeven graphs of RDF price versus boiler size.

CR 83.034
Evaluation of Naval Station Mayport Heat Recovery Incinerator, October 1981 - June 1982, Oxnard, Calif., VSE Corporation, Jun 1983, N00123-83-0-0149, ADA130445

This report is the second report which addresses the long-term evaluation of the Mayport Heat Recovery Incinerator program. Operational data were collected from 29 Sep 1981 to 27 Jun 1982 and then analyzed for reliability, availability, maintainability, thermal efficiency, and operating cost.

CR 83.035
Evaluation of the Naval Air Station Jacksonville Heat Recovery Incinerator, June - November 1982, Oxnard, Calif., VSE Corporation, Aug 1983, N00123-82-0149, ADB076625L

This report is the first report which addresses the long term evaluation of the NAS Jacksonville Heat Recovery Incinerator. Operational data were collected from June to November 1982 and then analyzed for reliability, availability and maintainability.

CR 83.036
A Method for Predicting Drag Anchor Holding Capacity, Houston, Tex., Brian Watt Associates, Inc., Aug 1983, N62474-82-C-8267, ADB076596L

The development of a method for the prediction of drag anchor holding capacity in soft cohesive soils is described. This method is unique in that it: (1) separates treatment of the anchor and the embedded mooring chain, (2) accounts for the soil cutting resistance mobilized by the embedded chain, and (3) incorporates the undrained soil shear strength in determining anchor and chain contributions. The method is applicable for several anchor types with (in-air) weights up to 50 kips. The method incorporates several chart-type design aids. An example drag anchor system design is included, along with a brief discussion of factors of safety appropriate for use with this new method.

CR 83.037
Selection and Implementation of Single Building EMCS, R. Stan, Dayton, Ohio, Stan and Associates, Inc., Aug 1983, N68305-3018-7940, ADA134006

This report addresses the selection and implementation of single building EMCS systems. The process is examined in three phases. The initial phase examines the selection of candidate buildings based on metered utility data, examination of building operation, examination of building systems and controls, and measured data. The second phase examines the capability of time clocks, duty cyclers, demand limiters, programmable controllers, micro EMCS and small EMCS. The functions performed by each are examined. Alternatives to EMCS are presented. An example calculation compares time clock control, time clock control with control enhancement, and small EMCS control of a typical air handling unit. The third phase examines the installation of equipment emphasizing interface techniques for efficient installation and operation. A summary of the analysis steps follows.

CR 83.038
Daylighting Coefficient of Utilization Tables, W. E. Brackett, Boulder, Colo., Applied Software Analysis, Aug 1983, N62583-83-MR-513, ADA134028

Use of daylighting coefficient of utilization tables provides a simple methodology for predicting interior illumination from daylight through windows. Tables are provided for transparent windows, and for windows with vertical and horizontal venetian blinds. The method predicts illuminance at five predefined target points within the room. The source code for the computer program which created the tables is included.

CR 83.039 - Cancelled

CR 83.040
Passive Solar Design Procedures for Naval Installations, W. O. Wray, F. A. Biehl, C. E. Kosiewicz, Los Alamos, N.M., Los Alamos National Laboratory, Solar Energy Group, Sep 1983, N 3305-82-MP-20006, N68305-82-MP-20010, ADA136329

The energy efficiency of buildings at Naval installations can be greatly improved through the use of passive solar heating strategies. These strategies may be applied to many existing buildings that are suitable for retrofit and are universally applicable to new construction. The purpose of this design procedure is to provide the tools required by professionals involved in building design and/or evaluation who wish to improve the energy efficiency of buildings by use of passive solar heating. Three types of tools are provided. First, a general discussion of the basic concepts and principles of passive solar heating is presented to familiarize the reader with this relatively new technology. Second, a set of guidelines is presented for use during schematic design that will enable the user to quickly define a building that will perform in a cost-effective manner at the intended building site. Finally, a quantitative design-analysis procedure is presented that provides the user with an accurate estimate of the auxiliary heating requirements of a given passive solar design. This procedure is presented that provides the user with an accurate estimate of the auxiliary heating requirements of a given passive solar design. This procedure may be used to refine or fine tune a preliminary design based on the schematic-design guidelines or may be used during proposal evaluation to compare the merits of various candidate designs.

SUBJECT INDEX

NCEL's Techdata Sheet series, which is not listed in the main body of the Guide, has been added to this index to facilitate activities in retrieving all formal documentation produced by the Laboratory. Interested activities can request any Techdata Sheet(s) by contacting NCEL, Code L08, directly.

PERSONAL AUTHOR INDEX

CORPORATE AUTHOR INDEX

VSE Corp. . . . . CR 80.004, CR 81.015
CR 82.029, CR 82.032, CR 82.033
CR 83.033, CR 83.034, CR 83.035

Waste Energy Technology Corp. . . . . CR 83.029
Western Instruments Corp. . . . . CR 82.014, CR 82.017
Westinghouse Electric Corp. . . . . CR 78.002
Oceanic Div. . . . . CR 80.015, CR 82.025, CR 82.026
Woodward-Clyde Consultants . . . . . CR 80.022
W. Rockenhauser . . . . . CR 73.009

AD NUMBER INDEX

AD523803L	- R-781	AD772537	- R-798	AD910117L	- CR 73.010	ADA011810	- N-1364
AD524141L	- R-782	AD773064	- N-1317	AD910118L	- CR 73.011	ADA011811	- R-819
AD532004	- N-1301	AD773065	- N-1315	AD910119L	- CR 73.012	ADA011812	- R-820
AD750258	- R-775	AD773066	- N-1310	AD910697L	- CR 73.015	ADA014173	- N-1392
AD753190	- R-778	AD773072	- N-1320	AD911175L	- CR 73.014	ADA014174	- N-1393
AD753194	- N-1253	AD773073	- N-1319	AD911293L	- N-1273	ADA014199	- N-1395
AD753195	- R-779	AD773074	- N-1312	AD912142L	- N-1278	ADA014200	- N-1397
AD754747	- N-1257	AD773090	- R-799	AD912748L	- N-1287	ADA014201	- R-823
AD754756	- N-1252	AD773945	- N-1322	AD912750	- N-1294	ADA014202	- R-824
AD756687	- CR 73.007	AD774080	- N-1331	AD912765	- N-1293	ADA014906	- CR 76.001
AD757675	- R-783	AD774081	- R-804	AD912815L	- N-1279	ADA017653	- N-1409
AD757704	- N-1254	AD774467	- R-800	AD912816L	- N-1304	ADA017692	- N-1404
AD757706	- N-1259	AD774468	- N-1318	AD913727L	- N-1290	ADA017693	- N-1399
AD757707	- N-1260	AD774469	- N-1313	AD914078	- R-792	ADA017695	- N-1407
AD757708	- N-1261	AD774470	- N-1302	AD914375L	- CR 74.004	ADA017697	- N-1406
AD757709	- N-1265	AD774473	- N-1299	AD915753L	- N-1291	ADA017698	- N-1405
AD757710	- N-1266	AD774478	- R-801	AD916101L	- N-1311	ADA017699	- N-1403
AD757715	- N-1264	AD774481	- R-802	AD916102L	- N-1300	ADA017700	- N-1396
AD758722	- CR 73.013	AD774482	- R-803	AD916353L	- N-1316	ADA017701	- N-1402
AD759673	- N-1263	AD774485	- N-1326	AD916357	- N-1321	ADA018908	- N-1411
AD759674	- N-1267	AD774486	- N-1314	AD916968L	- N-1330	ADA018950	- N-1416
AD759675	- N-1269	AD775658	- CR 74.005	AD916969L	- N-1325	ADA018952	- R-826
AD759676	- N-1270	AD776575	- R-794	AD916982	- N-1323	ADA018954	- N-1412
AD759683	- R-784	AD777030	- N-1328	AD917010L	- N-1309	ADA018956	- N-1415
AD759684	- R-785	AD777046	- N-1335	AD918221L	- N-1329	ADA019026	- R-828
AD762403	- N-1256	AD777047	- N-1333	AD918227L	- N-1332	ADA019027	- R-829
AD762404	- N-1271	AD777050	- N-1327	AD918951L	- N-1336	ADA019028	- N-1417
AD762405	- N-1274	AD777015	- N-1324	AD918952L	- N-1338	ADA019049	- N-1419
AD762406	- N-1276	AD777052	- N-1334	AD920678L	- R-812	ADA021279	- R-834
AD762407	- N-1281	AD777079	- R-805	AD922769L	- N-1346	ADA021841	- N-1379S
AD762408	- R-786	AD777084	- R-806	ADA002199	- N-1355	ADA021842	- N-1413
AD762409	- R-787	AD777471	- CR 74.006	ADA002216	- R-816	ADA021843	- N-1418
AD762410	- R-788	AD778329	- N-1337	ADA002217	- N-1358	ADA021844	- N-1421
AD763801	- CR 73.016	AD778333	- N-1339	ADA002218	- N-1359	ADA021845	- N-1422
AD764053	- N-1277	AD778334	- N-1340	ADA002219	- N-1361	ADA021867	- R-833
AD764054	- R-790	AD780343	- R-809	ADA002220	- N-1363	ADA021868	- R-831
AD764055	- N-1285	AD781638	- R-810	ADA002256	- N-1353	ADA021892	- N-1424
AD764056	- N-1284	AD781639	- R-813	ADA003590	- CR 75.003	ADA021965	- N-1410
AD764057	- N-1275	AD781640	- R-811	ADA003936	- CR 75.002	ADA022038	- CR 77.001
AD764058	- R-789	AD781644	- R-1341	ADA004928	- N-1370	ADA022142	- CR 76.003
AD765568	- N-1252S	AD781645	- N-1343	ADA004931	- N-1365	ADA022446	- R-837
AD765569	- N-1280	AD781677	- N-1342	ADA003932	- N-1369	ADA022450	- N-1426
AD765570	- N-1282	AD782503	- N-1345	ADA003933	- N-1375	ADA022458	- N-1427
AD765571	- N-1289	AD782508	- N-1349	ADA004934	- N-1373	ADA024038	- N-1432
AD766100	- R-793	AD782580	- N-1344	ADA004935	- N-1374	ADA024050	- N-1434
AD766101	- N-1297	AD782582	- R-814	ADA004936	- N-1360	ADA024051	- N-1431
AD766103	- R-791	AD782583	- N-1348	ADA004937	- N-1362	ADA024052	- R-838
AD767323	- N-1286	AD783100	- CR 74.009	ADA004939	- N-1366	ADA024053	- N-1425
AD767634	- N-1292	AD786336	- N-1354	ADA004954	- R-818	ADA024054	- R-839
AD767635	- N-1295	AD786346	- N-1350	ADA004988	- CR 75.004	ADA025400	- N-1429
AD767636	- N-1298	AD786349	- N-1352	ADA004989	- CR 75.005	ADA026106	- N-1433
AD767637	- N-1305	AD786350	- N-1347	ADA004990	- CR 74.008	ADA026107	- N-1435
AD768280	- N-1283	AD786357	- N-1357	ADA007488	- N-1380	ADA026139	- N-1440
AD768287	- CR 74.001	AD786369	- N-1351	ADA007489	- N-1371	ADA026188	- N-1430
AD768291	- N-1296	AD786487	- R-815	ADA007527	- N-1376	ADA026189	- N-1438
AD768292	- N-1306	AD786757	- CR 74.007	ADA009097	- R-817	ADA026190	- N-1439
AD768293	- N-1307	AD787067	- CR 75.001	ADA009247	- N-1384	ADA026191	- R-841
AD768278	- R-796	AD896813L	- R-795	ADA009248	- N-1385	ADA026192	- N-1436
AD768279	- R-797	AD905719L	- R-776	ADA011054	- CR 75.007	ADA026198	- R-842
AD768373	- CR 74.002	AD905720	- R-780	ADA011103	- CR 75.008	ADA026202	- N-1441
AD769672	- N-1262	AD905721L	- R-777	ADA011805	- N-1387	ADA026251	- N-1442
AD772514	- N-1272	AD906998	- N-1255	ADA011806	- N-1389	ADA026252	- N-1443
AD772515	- N-1288	AD907010L	- N-1258	ADA011807	- N-1390	ADA026253	- N-1444
AD772516	- N-1303	AD908619	- N-1268	ADA011808	- R-822	ADA026338	- N-1437
AD772527	- N-1308	AD910116L	- CR 73.010	ADA011809	- N-1388	ADA028607	- N-1446

ADA028616	- N-1447	ADA047995	- N-1501	ADA066128	- N-1537	ADA085449	- N-1571
ADA028617	- N-1445	ADA047996	- N-1499	ADA066145	- N-1539	ADA085510	- N-1562
ADA028618	- R-843	ADA048057	- N-1502	ADA066187	- N-1533	ADA085521	- R-876
ADA028619	- R-845	ADA048058	- N-1504	ADA066221	- N-1534	ADA085612	- CR 80.011
ADA028620	- R-844	ADA048263	- CR 78.001	ADA066225	- N-1538	ADA085815	- R-877
ADA028660	- N-1367	ADA048441	- CR 78.002	ADA066258	- N-1535	ADA086854	- CR 80.019
ADA029378	- CR 76.004	ADA049229	- N-1505	ADA066259	- N-1543	ADA087282	- CR 80.016
ADA030280	- CR 77.002	ADA049244	- N-1503	ADA066297	- N-1542	ADA087321	- N-1580
ADA030872	- N-1452	ADA049248	- R-852-III	ADA066302	- N-1541	ADA088185	- CR 80.022
ADA030941	- N-1453	ADA049254	- N-1506	ADA067463	- CR 79.005	ADA089146	- CR 80.023
ADA030997	- N-1449	ADA049276	- CR 77.016	ADA068332	- CR 79.006	ADA089262	- N-1577
ADA030998	- N-1451	ADA049552	- R-859	ADA068690	- CR 79.008	ADA089266	- N-1578
ADA031045	- N-1448	ADA050262	- R-852-II	ADA068691	- CR 79.009	ADA089269	- R-879
ADA031046	- N-1450	ADA050797	- N-1514	ADA068748	- CR 79.007	ADA089299	- N-1575
ADA033482	- N-1461	ADA050881	- N-1507	ADA070850	- N-1549	ADA089300	- R-878
ADA033493	- R-847	ADA050882	- R-858	ADA070855	- N-1544	ADA089335	- CR 80 024
ADA033494	- N-1455	ADA050883	- R-857	ADA070856	- N-1545	ADA090828	- N-1588
ADA033551	- N-1456	ADA050884	- N-1513	ADA070857	- N-1546	ADA091517	- CR 80.027
ADA033558	- R-846	ADA051101	- CR 78.003	ADA070858	- N-1547	ADA091616	- CR 80.028
ADA033665	- N-1458	ADA051184	- R-860	ADA070859	- N-1548	ADA091672	- N-1569
ADA035800	- N-1466	ADA051489	- N-1511	ADA070860	- N-1550	ADA091738	- CR 80.026
ADA035801	- N-1462	ADA051868	- N-1512	ADA070861	- N-1552	ADA092899	- N-1573
ADA035802	- N-1464	ADA053505	- R-861	ADA070862	- N-1551	ADA092945	- N-1561S
ADA035904	- R-849	ADA053506	- N-1515	ADA070864	- R-869	ADA092946	- N-1585
ADA036158	- R-850	ADA053507	- N-1516	ADA070865	- R-870	ADA092958	- N-1592
ADA036917	- N-1469	ADA053557	- R-863	ADA070953	- R-872	ADA092960	- N-1583
ADA036931	- N-1468	ADA054215	- N-1517	ADA071673	- CR 79.011	ADA093071	- N-1582
ADA037164	- CR 77.010	ADA054476	- N-1519	ADA073002	- CR 79.014	ADA093078	- N-1579
ADA037873	- N-1474	ADA054601	- R-835	ADA073026	- CR 79.012	ADA093088	- N-1581
ADA037951	- R-851	ADA054720	- R-865	ADA073301	- N-1554	ADA093093	- N-1576
ADA038417	- N-1472	ADA054767	- R-864	ADA074504	- CR 79.010	ADA093356	- N-1584
ADA039096	- CR 77.006	ADA055601	- N-1518	ADA074836	- CR 79.015	ADA096852	- N-1587
ADA039181	- N-1473	ADA055609	- CR 78.012	ADA074871	- CR 79.013	ADA096853	- N-1594
ADA039288	- N-1475	ADA055623	- CR 78.007	ADA075739	- N-1561	ADA096854	- N-1589
ADA039609	- N-1478	ADA055624	- CR 78.010	ADA077868	- CR 79.016	ADA097116	- R-882
ADA039801	- N-1479	ADA055918	- CR 78.011	ADA078618	- N-1555	ADA097118	- R-881
ADA039821	- R-852-I	ADA055926	- N-1520	ADA078619	- N-1558	ADA097119	- R-880
ADA040278	- R-848	ADA056603	- CR 78.008	ADA078641	- R-874	ADA097120	- N-1591
ADA041164	- N-1483	ADA056604	- CR 78.009	ADA078653	- N-1556	ADA097133	- N-1593
ADA041235	- CR 77.015	ADA057405	- CR 78.014	ADA078654	- N-1553	ADA097162	- N-1590
ADA041305	- N-1484	ADA057684	- R-866	ADA078655	- R-871	ADA097870	- CR 81.001
ADA041605	- CR 77.017	ADA057941	- N-1521	ADA078726	- R-873	ADA099559	- CR 81.012
ADA041653	- N-1482	ADA057942	- N-1522	ADA078740	- N-1557	ADA099884	- CR 81.013
ADA041860	- CR 77.013	ADA058028	- CR 78.016	ADA079740	- N-1557	ADA100765	- CR 81.014
ADA042164	- R-852-V	ADA058144	- CR 78.017	ADA080322	- CR 80.003	ADA101379	- CR 81.015
ADA042181	- N-1487	ADA058713	- N-1523	ADA080564	- CR 80.004	ADA102196	- N-1609
ADA042385	- CR 77.014	ADA058726	- N-1524	ADA081154	- N-1560	ADA102473	- CR 81.020
ADA042906	- N-1489	ADA058858	- CR 78.013	ADA081230	- CR 80.002	ADA102888	- CR 81.016
ADA043366	- N-1480	ADA059698	- CR 78.018	ADA081261	- CR 80.005	ADA103071	- N-1596
ADA043430	- R-852-IV	ADA060094	- N-1527	ADA081381	- CR 80.006	ADA103072	- N-1597
ADA043582	- R-854-11	ADA060204	- R-867	ADA081384	- CR 80.006	ADA103073	- N-1600
ADA043605	- R-854-I	ADA060323	- N-1525	ADA081944	- N-1566	ADA103105	- N-1595
ADA043912	- R-855	ADA060422	- N-1526	ADA082165	- CR 80.018	ADA103107	- N-1598
ADA043918	- N-1493	ADA060475	- CR 78.019	ADA082737	- CR 80.001	ADA103431	- CR 81.017
ADA043950	- N-1490	ADA062432	- N-1529	ADA084840	- CR 80.013	ADA103432	- CR 81.018
ADA043951	- CR 77.018	ADA062433	- N-1530	ADA084920	- CR 80.015	ADA103433	- CR 81.019
ADA043968	- R-856	ADA062434	- N-1528	ADA085222	- CR 80.012	ADA108384	- CR 82.004
ADA043995	- N-1496	ADA062435	- N-1531	ADA085257	- N-1570	ADA108385	- CR 82.005
ADA044337	- CR 77.008	ADA062988	- CR 78.021	ADA085286	- N-1564	ADA108386	- CR 82.006
ADA044588	- N-1495	ADA064771	- CR 79.002	ADA085287	- N-1565	ADA110189	- CR 82.007
ADA045465	- N-1494	ADA064858	- CR 79.001	ADA085288	- N-1572	ADA110190	- CR 82.010
ADA045468	- N-1497	ADA065403	- CR 79.004	ADA085291	- R-875	ADA110325	- R-888
ADA045583	- CR 77.020	ADA065415	- CR 79.003	ADA085357	- N-1563	ADA110337	- N-1613
ADA046016	- N-1491	ADA066024	- N-1540	ADA085446	- N-1574	ADA110440	- N-1610
ADA046022	- N-1498	ADA066115	- R-868	ADA085447	- N-1568	ADA112043	- CR 82.012

ADA112550	- CR 82.011	ADA128761	- N-1655	ADB056254L	- CR 81.010	ADB077668L	- N-1676
ADA113673	- CR 82.013	ADA128764	- N-1659	ADB056270L	- CR 81.005	ADC004138L	- R-825
ADA114320	- N-1617	ADA128767	- N-1643	ADB056552L	- CR 81.009	ADC005278	- N-1391S
ADA114323	- N-1618	ADA128772	- N-1654	ADB056784L	- CR 81.011	ADC009818L	- CR 77.005
ADA114331	- N-1622	ADA128773	- N-1653	ADB058916L	- N-1602	ADC013504L	- N-1509S
ADA114460	- CR 82.021	ADA128790	- N-1661	ADB058917L	- N-1601		
ADA114461	- CR 82.020	ADA129257	- N-1663	ADB058918L	- N-1603		
ADA114957	- CR 82.015	ADA129732	- CR 83.001	ADB058922L	- R-884		
ADA114960	- CR 82.025	ADA129872	- R-900	ADB058923L	- R-885		
ADA114961	- CR 82.016	ADA130444	- CR 83.033	ADB058924L	- R-886		
ADA114978	- CR 82.014	ADA130445	- CR 83.034	ADB058925L	- R-887		
ADA114994	- CR 82.019	ADA130563	- CR 83.031	ADB058926L	- N-1599		
ADA115041	- CR 82.018	ADA131254	- CR 83.028	ADB058927L	- N-1604		
ADA115019	- CR 82.017	ADA131463	- CR 83.032	ADB058928L	- N-1606		
ADA115523	- CR 82.022	ADA131879	- CR 83.019	ADB058929L	- N-1608		
ADA116588	- N-1626	ADA133072	- N-1673	ADB058944L	- N-1607		
ADA116589	- N-1630	ADA133107	- N-1666	ADB058946L	- CR 81.023		
ADA116594	- N-1620	ADA133142	- N-1664	ADB059012L	- N-1605		
ADA116597	- N-1627	ADA133144	- N-1671	ADB059013L	- R-883		
ADA116835	- CR 82.027	ADA133149	- N-1672	ADB059235L	- CR 81.022		
ADA118523	- CR 82.029	ADA133240	- R-899	ADB060633L	- CR 81.024		
ADA118898	- CR 82.028	ADA133640	- N-1677	ADB062342L	- N-1611		
ADA119389	- N-1641	ADA133670	- N-1670	ADB062343L	- N-1612		
ADA119979	- N-1634	ADA133701	- R-903	ADB062344L	- N-1614		
ADA119984	- N-1628	ADA133717	- N-1674	ADB062345L	- N-1616		
ADA120023	- N-1636	ADA134006	- CR 83.037	ADB063763L	- R-890		
ADA120024	- N-1640	ADA134028	- CR 83.038	ADB064443L	- N-1621		
ADA120025	- R-882S	ADA136329	- CR 83.040	ADB064462L	- R-891		
ADA120639	- CR 82.001	ADA137438	- CR 82.008	ADB064681L	- CR 82.026		
ADA121864	- CR 83.004	ADB000410L	- N-1356	ADB065574L	- N-1629		
ADA121865	- CR 82.031	ADB000417L	- R-807	ADB065575L	- N-1623		
ADA122203	- CR 83.006	ADB001631L	- N-1368	ADB065621L	- N-1631		
ADA122408	- CR 82.032	ADB002855L	- R-808	ADB065622L	- N-1624		
ADA122638	- CR 82.033	ADB002856L	- R-808S	ADB065623L	- N-1619		
ADA123383	- CR 82.030	ADB002852L	- N-1379	ADB065655L	- R-892		
ADA123673	- CR 83.008	ADB002853L	- N-1377	ADB065661L	- R-893		
ADA123821	- CR 83.003	ADB002854L	- N-1372	ADB065667L	- N-1625		
ADA124047	- CR 83.002	ADB002864L	- N-1378	ADB066649L	- R-894		
ADA124215	- CR 83.009	ADB002865L	- N-1382	ADB067752L	- R-896		
ADA124235	- N-1649	ADB002866L	- N-1383	ADB068191L	- N-1632		
ADA124244	- N-1644	ADB002871L	- N-1381	ADB068192L	- N-1638		
ADA124245	- N-1647	ADB004842L	- R-821	ADB068205L	- R-895		
ADA124267	- N-1639	ADB004843L	- N-1391	ADB068224L	- N-1635		
ADA124866	- CR 83.010	ADB004844L	- N-1386	ADB068225L	- N-1633		
ADA124867	- CR 83.011	ADB006046L	- N-1394	ADB068213L	- N-1637		
ADA124868	- CR 83.013	ADB006047L	- N-1398	ADB070300L	- N-1645		
ADA124994	- CR 83.012	ADB007688L	- N-1400	ADB070930L	- N-1646		
ADA125157	- CR 83.016	ADB007689L	- N-1401	ADB070971L	- CR 83.007		
ADA125159	- CR 83.014	ADB008311L	- N-1408	AD8073370	- N-1650		
ADA125160	- CR 83.015	ADB008312L	- R-827	ADB073715L	- N-1652		
ADA125180	- CR 82.034	ADB009553L	- R-830	ADB073716L	- N-1651		
ADA125264	- CR 83.005	ADB009723L	- R-832	ADB073717L	- N-1648		
ADA125543	- CR 83.017	ADB009724L	- N-1420	ADB073727L	- N-1660		
ADA126315	- N-1656	ADB009725L	- N-1423	ADB073775L	- R-897		
ADA126860	- CR 83.020	ADB009960L	- R-836	ADB074245L	- N-1665		
ADA127249	- CR 83.022	ADB009984L	- N-1338S	ADB074755L	- CR 83.030		
ADA127461	- CR 83.025	ADB010796L	- N-1428	ADB076596L	- CR 83.036		
ADA128087	- CR 83 021	ADB011919L	- R-840	ADB076625L	- CR 83.035		
ADA128204	- CR 83.023	ADB012697	- N-1414	ADB076808L	- N-1662		
ADA128407	- CR 83.024	ADB015607L	- N-1454	ADB076816L	- R-901		
ADA128562	- CR 83.018	ADB015608L	- N-1457	ADB076834L	- N-1668		
ADA128588	- CR 83.029	ADB016588L	- N-1465	ADB076858L	- N-1667		
ADA128617	- CR 83.027	ADB055330L	- CR 81.007	ADB077212L	- R-902		
ADA128748	- N-1658	ADB055332L	- CR 81.006	ADB077253L	- N-1675		
ADA128756	- R-898	ADB055335L	- CR 81.008	ADB077257L	- N-1669		

CONTRACT NUMBER INDEX

N68305-74-C-0002
CR 76.003
N68305-74-C-0010
CR 74.009
N68305-74-C-0014
CR 76.001

N68305-75-C-0004
CR 77.001, CR 77.002

N68305-76-C-0003
CR 77 017
N68305-76-C-0007
CR 77.009
N68305-76-C-0009
CR 77.013, CR 77.014
N68305-76-C-0014
CR 78.003
N68305-76-C-0015
CR 77.010
N68305-76-C-0017
CR 79.015
N68305-76-C-0018
CR 76.004
N68305-76-C-0025
CR 77.011
N68305-76-C-0029
CR 77.018
N68305-76-C-0033
CR 79.006, CR 79.007, CR 79.008, CR 79.009
N68305-76-C-0036
CR 78.011
N68305-76-C-0038
CR 77.006

N68305-77-C-0001
CR 78.012
N68305-77-C-0003
CR 78.014, CR 79.012, CR 80.023
N68305-77-C-0005
CR 78.018, CR 79.013
N68305-77-C-0009
CR 78.006
N68305-77-C-0012
CR 78.008, CR 78.009
N68305-77-C-0013
CR 77.020
N68305-77-C-0014
CR 78.010
N68305-77-C-0017
CR 78.002
N68305-77-C-0018
CR 78.013, CR 78.016, CR 78.017, CR 78.021
N68305-77-C-0019
CR 78.005
N68305-77-C-0021
CR 78.019
N68305-77-C-0032
CR 79.001
N68305-77-C-0035
CR 81.010
N68305-77-C-0037
CR 79.003
N68305-77-C-0039
CR 78.015
N68305-77-C-0041
CR 78.007

N68305-78-C-0006
CR 80.014
N68305-78-C-0009
CR 80.006
N68305-78-C-0010
CR 79.004
N68305-78-C-0011
CR 79.002

N68305-78-C-0018
CR 79.011
N68305-78-C-0021
CR 80.011
N68305-78-C-0025
CR 79.016
N68305-78-C-0036
CR 79.005
N68305-78-C-0046
CR 80.010, CR 81.002
N68305-78-C-0048
CR 79.014
N68305-78-C-0049
CR 81.005
N68305-78-C-0051
CR 79.010
N68305-78-C-0056
CR 80.012

N68305-79-C-0008
CR 80.001
N68305-79-C-0009
CR 80.026, CR 80.027, CR 80.028
N68305-79-C-0021
CR 80.016, CR 80.024
N68305-79-C-0026
CR 81.009
N68305-79-C-00344
CR 83.018
N68305-79-C-0036
CR 81.017, CR 81.018, CR 81.019

N68305-80-C-0004
CR 82.014, CR 82.017
N68305-80-C-0006
CR 81.012
N68305-80-C-0007
CR 80.022
N68305-80-C-0012
CR 81.026, CR 83.009
N68305-80-C-0016
CR 81.004
N68305-80-C-0017
CR 81.011
N68305-80-C-0020
CR 81.023, CR 82.015
N68305-80-C-0031
CR 82.021
N68305-80-C-0037
CR 81.022
N68305-80-C-0053
CR 82.008
N68305-80-C-0055
CR 82.001
N68305-80-C-0056
CR 81.016
N68305-80-C-0060
CR 83.016, CR 83.028
N68305-80-C-0063
CR 81.024
N68305-80-C-0064
CR 81.014

N68305-81-MP-10003
CR 82.007
N68305-81-MP-10027
CR 82.034

N68305-82-MP-20006
CR 83.040
N68305-82-MP-20010
CR 83.040

N68305-82-WR-20092
CR 83.004
N68305-82-WR-20172
CR 83.031

N68305-3018-7940
CR 83.037

DNA001-79-C-0182
CR 80.013
F33615-77-C-2004
CR 81.013
F41608-79-C-A011-0008
CR 80.025
P.O. 80-MR-755
CR 81.015